



American  
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# Journal of Dental Hygiene

THE AMERICAN DENTAL HYGIENISTS' ASSOCIATION

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- A Center for Oral Health Promotion: Establishing an Inter-Professional Paradigm for Dental Hygiene, Health Care Management and Nursing Education
- Probiotics for Periodontal Health: A Review of the Literature
- Diabetes Educators' Knowledge, Opinions and Behaviors Regarding Periodontal Disease and Diabetes
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- Assessment and Maintenance of Dental Implants: Clinical and Knowledge-Seeking Practices of Dental Hygienists
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- Oral Health Students as Reflective Practitioners: Changing Patterns of Student Clinical Reflections over a Period of 12 Months
- Comparing the Risk Identification and Management Behaviors between Oral Health Providers for Patients with Diabetes
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- A Comparison of Dental Ultrasonic Technologies on Subgingival Calculus Removal: A Pilot Study

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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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## The Need for Inter-Professional Collaboration

I was recently contacted by the editor of a diabetes practice group publication for the Academy of Nutrition and Dietetics (formerly American Dietetic Association). At their executive board's recent brainstorming session on possible topics on diabetes and co-morbidities, one of the rather interesting topics, as the editor phrased it, was the effect of diabetes on oral health. All of the committee members agreed that most registered dietitians probably don't fully understand the impact that diabetes may have on teeth and gums. As a dual-degree registered dental hygienist and registered dietitian, I have always been intrigued by the oral systemic link and the practical application to patient management. I am passionate about the development of inter-professional relationships and creating a more collaborative framework of health care.

Several of the topics in this issue spotlight the need to develop alliances with other health care professionals. Many disease states, including oral disease, are multifactorial. Collaborative efforts among the health care system are needed to effectively treat and control certain conditions. Identifying barriers to care and establishing creative ways to provide access will help move our profession forward.

On May 25, 2000, Surgeon General David Satcher released the 51st Surgeon General's report entitled *Oral Health in America: A Report of the Surgeon General*. It was a significant call for action to promote access to care as well as to create a public awareness about the importance of oral health and the implications for total health and well being. In his report, Satcher stated that "the mouth is the window to all of the diseases of the body."<sup>1</sup> Those words heightened our role as a profession. I personally felt it added more credibility to our role as health care providers. In 2003, as a follow up, Surgeon General Richard Carmona released the *National Call to Action* with set strategies to address the oral health concerns previously noted in Satcher's report. The report delineated 5 primary constructs:

1. Change perceptions of oral health care

2. Overcome barriers by replicating effective programs and proven efforts
3. Build a science base and accelerate science transfer
4. Increase oral health workforce diversity, capacity and flexibility
5. Increase collaborations<sup>2</sup>

As a preceptor for the Baylor University Medical Center Dietetic Internship program, each year I provide a lecture during fall orientation on oral health, nutrition and the implication to practice as a licensed dietitian. In the fall of 2005, I implemented a rotation for the interns in our dental clinic. Each dietetic intern spends a half day partnered with a dental hygiene student observing the intricacies of the dental hygiene assessment and diagnosis process. Typically the dental hygiene student will ask their patient questions regarding dietary practices to determine the need for nutritional counseling based on other oral disease risk factors identified during the assessment process. During the rotation, the dietetic intern asks the questions regarding dietary practices so that the hygiene student can observe the detailed manner in which the intern elicits this information from the patient. The dietetic intern is instructed on form, frequency and timing of food consumption and how these factors can influence a patient's caries risk. Prior to the rotation, the dietetic interns are asked to keep a 3 day food record. During the half-day segment in the dental clinic, I review their dietary intake with them from a dental perspective. Following the rotation, dietetic interns are asked to submit a 1 to 2 page reflection paper, discussing how their perception of oral health in relation to their role as a dietitian may or may not have changed as a result of the experience. It is enlightening to see how many of the dietetic interns never even considered the diet-dental relationship prior to the dental hygiene clinical rotation and the impact provided through this experience. In turn, it is refreshing to see the dental hygiene students mutually interact with the interns. The primary purpose in development of this rotation was to cultivate an inter-professional relationship at the student level with hopes that both the dietetic intern and

the dental hygiene student see the value in one another's profession and to encourage alliance with one another when they are licensed health care professionals.

An unknown author once said "Just because you're not sick doesn't mean you're healthy." This quote came to mind as I considered the topics in the current issue. Satcher pointed out in his report that there are many oral diseases and conditions that can be associated with other health problems. When we treat patients, we are not just concerned with their oral care but all the other conditions — diagnosed and undiagnosed that they may be bringing with them into the patient operatory and how these conditions may impact their course of treatment. Diabetes is among these conditions. According to 2011 data from the Centers for Disease Control and prevention, diabetes affects 25.8 million children and adults in the United States.<sup>3</sup> Seventy-nine million have pre-diabetes.<sup>3</sup> There are 18.8 million diagnosed cases of diabetes but even more concerning is the 7 million undiagnosed cases.<sup>3</sup> Evidence-based literature indicates that poor glycemic control can exacerbate the periodontal condition. Conversely, it has been demonstrated that periodontal health can have an impact on regulation of blood sugars. Additionally, there have been studies over the past few years that have looked at dental patient populations in regards to risk for cardiovascular disease incident. Ironically, those individuals that were determined to be at greatest risk were relatively healthy and were on no medications for high blood pressure, cholesterol or diabetes. The majority of these individuals had not seen a physician in the last year but had been to a dentist. The value of our role in identification of risk factors that may indicate an underlying

medical condition is tremendous.<sup>4,5</sup> However, a recent release from the American Heart Association states findings that there is not enough conclusive evidence that periodontal disease causes or increases the rate of cardiovascular disease.<sup>6</sup>

So what now? Most systemic conditions are causally related to oral health — this isn't anything new. Our role is not to alarm patients but to thoroughly assess, educate and provide preventive care, so it should be business as usual. Practitioners must provide a thorough review of the medical history, ask probing questions at each dental visit and follow up with medical providers as indicated. These steps are key to identifying risk factors that may indicate need for referral to other health care providers.

As dental hygienists, we are in a unique position to impact the lives of our patients from a total health standpoint. A little over a decade after the release of the 51<sup>st</sup> Surgeon General's report, what have we done as a profession to respond to this call? We are in need of a paradigm shift to create versatility and opportunities for our profession. Fostering inter-professional partnerships will help us to change the perception of oral health and overcome barriers to provide optimum preventive care.

Sincerely,  
Lisa F. Mallonee, RDH, MPH, RD, LD

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# Linking Research to Clinical Practice

## Flossing or Alternative Interdental Aids?

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.**

**Sambunjak D, Nickerson JW, Poklepovic T, Johnson TM, Imai P, Tugwell P, Worthington HV. Flossing for the management of periodontal diseases and dental caries in adults. Cochrane Database of Systematic Reviews 2011, Issue 12. Art. No.: CD008829. DOI:10.1002/14651858.CD008829.pub2.**

**Background:** Good oral hygiene is thought to be important for oral health. This review is to determine the effectiveness of flossing in addition to toothbrushing for preventing gum disease and dental caries in adults.

**Objectives:** To assess the effects of flossing in addition to toothbrushing, as compared with toothbrushing alone, in the management of periodontal diseases and dental caries in adults.

**Search methods:** We searched the following electronic databases: the Cochrane Oral Health Group Trials Register (to 17 October 2011), the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library 2011, Issue 4), MEDLINE via OVID (1950 to 17 October 2011), EMBASE via OVID (1980 to 17 October 2011), CINAHL via EBS-CO (1980 to 17 October 2011), LILACS via BIREME (1982 to 17 October 2011), ZETOC Conference Proceedings (1980 to 17 October 2011), Web of Science Conference Proceedings (1990 to 17 October 2011), Clinicaltrials.gov (to 17 October 2011) and the metaRegister of Controlled Clinical Trials (to 17 October 2011). We imposed no restrictions regarding language or date of publication. We contacted manufacturers of dental floss to identify trials.

**Selection criteria:** We included randomized controlled trials conducted comparing toothbrushing

and flossing with only toothbrushing, in adults.

**Data collection and analysis:** Two review authors independently assessed risk of bias for the included studies and extracted data. We contacted trial authors for further details where these were unclear. The effect measure for each meta-analysis was the standardized mean difference (SMD) with 95% confidence intervals (CI) using random-effects models. We examined potential sources of heterogeneity, along with sensitivity analyses omitting trials at high risk of bias.

**Main results:** Twelve trials were included in this review, with a total of 582 participants in flossing plus toothbrushing (intervention) groups and 501 participants in toothbrushing (control) groups. All included trials reported the outcomes of plaque and gingivitis. Seven of the included trials were assessed as at unclear risk of bias and 5 were at high risk of bias. Flossing plus toothbrushing showed a statistically significant benefit compared to toothbrushing in reducing gingivitis at the 3 time points studied, the SMD being -0.36 (95% CI -0.66 to -0.05) at 1 month, SMD -0.41 (95% CI -0.68 to -0.14) at 3 months and SMD -0.72 (95% CI -1.09 to -0.35) at 6 months. The 1 month estimate translates to a 0.13 point reduction on a 0 to 3 point scale for Loe-Silness gingivitis index, and the 3 and 6 month results translate to 0.20 and 0.09 reductions on the same scale. Overall there is weak, very unreliable evidence which suggests that flossing plus toothbrushing may be associated with a small reduction in plaque at 1 or 3 months. None of the included trials reported data for the outcomes of caries, calculus, clinical attachment loss or quality of life. There was some inconsistent reporting of adverse effects.

**Authors' conclusions:** There is some evidence from 12 studies that flossing in addition to toothbrushing reduces gingivitis compared to toothbrushing alone. There is weak, very unreliable evidence from 10 studies that flossing plus toothbrushing may be associated with a small reduction in plaque at 1 and 3 months. No studies reported the effectiveness of flossing plus toothbrushing for preventing dental caries.

## Commentary

This abstract reports results of a systematic review with meta-analysis. A systematic review is a study designed to answer a research question by comprehensively collecting and evaluating published studies. All of the studies that meet pre-established criteria for the highest level of evidence are systematically identified, appraised and summarized according to a precise methodology. Meta-analysis adds an additional step by statistically combining results of some or all of the included studies. Studies that are similar enough statistically to combine, synthesize and analyze are merged as if the data were generated from one study. For research questions about therapies or preventive strategies, a systematic review or meta-analysis of randomized clinical trials (RCTs) is considered the highest level of evidence available. This systematic review and meta-analysis used only RCTs "to assess the effects of flossing in addition to toothbrushing, as compared with toothbrushing alone, in the management of periodontal diseases and dental caries in adults." Of 975 studies found, 859 were judged irrelevant and, ultimately, only 12 articles were judged independently by 3 reviewers to meet pre-established criteria for inclusion. The meta-analysis included all RCTs that compared toothbrushing (manual or power) and flossing to toothbrushing alone or toothbrushing plus a negative control, for example a placebo (inactive) mouthrinse. These 12 studies combined included 582 participants in flossing plus toothbrushing (intervention) groups and 501 participants in toothbrushing (control) groups for the meta-analysis.

The authors explained that this review was significant because there are many interdental cleaning aids available, but compliance issues are associated with regular use of these aids. Dental floss is one of the most common, if not the most common, interdental aid recommended by dental hygienists and dentists and advertised to consumers. Nonetheless, it is time consuming and challenging for some and has associated costs for all who use it. Most dental hygienists know that patient adherence with a recommendation for daily flossing is low. A position paper by the Canadian Dental Hygienists' Association (CDHA) indicates that research has shown that daily

use ranges from 10 to 30% of adults.<sup>1</sup> Reasons for low compliance were related to a lack of patients' abilities and motivation. Also, some patients who attempt regular flossing do not use proper technique, simply passing floss through the contacts without effectively removing plaque biofilm.

The first objective of this systematic review was to evaluate effectiveness of flossing in addition to toothbrushing in adults for the management of periodontal diseases. Generally, inflammatory periodontal diseases are caused by, or exacerbated by, the complex interaction between infectious agents found in the microbial biofilm known as plaque and host factors in a susceptible individual. The studies included in this systematic review assessed periodontal diseases by gingivitis indices measuring gingival inflammation or bleeding, or both. Frequency of flossing was once daily in most studies, and all but 1 reported teaching patients to floss. The minimum duration of assessments included was 4 weeks. Trials evaluated manual or automated flossing. Six studies were conducted for 3 months, and 6 studies were at least 6 months, with only 1 of those extending to 9 months. At all time periods, 1, 3 and 6 months, there was some evidence that flossing reduced gingivitis. Although statistically significant, the standardized mean difference in gingivitis scores was small. On a scale of 0 to 3, the flossing group averaged 0.36, 0.41 and 0.72, less than the toothbrushing only group at 1, 3 and 6 months, respectively. These small differences in gingivitis scores may not be clinically significant, especially at 1 and 3 months.

Ten studies reported plaque outcomes that could be used in the meta-analysis. Interestingly, the evidence was weak, indicating a small possible benefit for flossing beyond toothbrushing for plaque removal. Perhaps the effect of flossing on plaque extends beyond the line angle into the interproximal area where plaque cannot be seen and scored.

Of the 12 studies included, 7 studies were industry-sponsored. One cannot assume that all industry-sponsored research is biased; however, the question arises when evaluating research findings. These authors conducted a sensitivity analysis and eliminated all articles with a high risk of bias to determine if industry-sponsored studies biased results of the meta-analysis. They found that excluding the industry-sponsored studies did not change the outcomes for either gingivitis or plaque at 1, 3 and 6 months.

Harms and adverse effects were reported in 5 studies. The most frequent harm identified was soft tissue/gingival trauma, a reversible event. Most

patients would avoid flossing in traumatized areas and the areas would heal. The desirable benefits of flossing in reducing gingivitis seem to outweigh the potential harms.

A previous systematic review by Berchier et al assessed the effect of both flossing and toothbrushing versus toothbrushing alone on plaque and gingivitis.<sup>2</sup> Those authors concluded that adding dental floss provided no additional benefit. The current systematic review agreed with the former study's findings in relation to plaque; however, this review found a statistically significant benefit for flossing in reducing gingivitis. Seven of the 12 articles used in this review were common to the previous review, and 1 study was common in the meta-analysis. Different outcomes would be expected with different studies included.

The second objective of this systematic review was to evaluate effectiveness of flossing, in addition to toothbrushing, in adults, for the management of dental caries. Studies of dental caries take longer than studies of periodontal disease, especially gingivitis. The effect of plaque biofilm as an etiological factor also is compounded by the fact that formation of a carious lesion requires a susceptible tooth surface, sufficient numbers of cariogenic bacteria, frequent exposure to fermentable carbohydrates and a susceptible host. Fluoride also affects caries outcomes. Perhaps due to these factors, no studies were identified that reported dental caries outcomes in adults. Therefore, there is insufficient evidence to state whether flossing, in addition to toothbrushing, is effective in reducing dental decay. A previous systematic review also found no studies in adults that were eligible for inclusion; however, professional flossing in children with low fluoride exposure was found to be highly effective.<sup>3</sup> Daily professional flossing is not practical or typical, and evidence supporting self-flossing in children is weak. Effective toothbrushing, fluoride therapy and dietary modifications are more strongly supported than flossing in regards to caries prevention.

**Toma´s I, Diz P, Tobí´as A, Scully C, Donos N. Periodontal health status and bacteraemia from daily oral activities: systematic review/meta-analysis. J Clin Periodontol 2012; 39: 213–228. doi: 10.1111/j.1600-051X.2011.01784.x.**

**Aim:** The aim of this study was to investigate the robustness of the observations on the influence of oral hygiene, gingival and periodontal status on the development of bacteraemia from everyday oral activities (B–EOA), analyzing its prevalence, duration, magnitude and bacterial diversity.

**Material and Methods:** This systematic review/meta-analysis complies with PRISMA reporting guidelines. MEDLINE–PubMed, the Cochrane Library and Embase were explored for detecting studies on B–EOA.

**Results:** There were 290 potentially eligible articles, of which 12 articles on B–EOA fulfilled the inclusion criteria and were processed for data extraction (7 on toothbrushing, 1 on dental flossing and 4 on chewing). Evaluating the influence of plaque and gingival indices on the prevalence of bacteraemia following toothbrushing, the pooled odds ratios were 2.61 (95% confidence interval (CI)=1.45 to 4.69) and 2.77 (95% CI=1.50 to 5.11), respectively. None of the 5 studies on bacteraemia following dental flossing and chewing revealed a statistically significant association between oral hygiene, gingival or periodontal status and the development of bacteraemia.

**Conclusions:** Meta-analysis showed that plaque accumulation and gingival inflammation scores significantly increased the prevalence of bacteraemia following toothbrushing. However, systematic review showed no relationship between oral hygiene, gingival and periodontal status and the development of B–chewing, and there is no evidence that gingival and periodontal health status affects B–flossing.

## Commentary

Irregular oral hygiene care is considered a possible source of bacteremia. Bacteremia that originates in the mouth is defined as oral bacteria present in the bloodstream following dental procedures or everyday oral activities (B–EOA) such as toothbrushing and flossing. An increased emphasis on B–EOA stems from guidelines for antibiotic prophylaxis revised 5 years ago and published in several countries. Guidelines published by the American Heart Association state, "Maintenance of optimal oral hygiene and periodontal health may reduce the incidence of B–EOA and is more important than prophylactic antibiotics for a dental procedure to reduce the risk of IE (infective endocarditis)."<sup>4</sup> Dental professionals who had been recommending antibiotic prophylaxis for invasive dental procedures for years were prompted to view the issue of bacteremia from a new vantage point.

The authors of this systematic review explain the clinical importance of B–EOA is based on a cumulative effect of collective exposures. In other words, a periodontal debridement or tooth extraction is a one-time event, whereas toothbrushing potentially occurs multiple times daily. While bacteremia following toothbrushing, dental flossing and oral irri-



gation is low intensity, the intensity has been shown to increase over baseline for all of these oral hygiene techniques. These authors summarize results of other studies indicating that bacteremia following toothbrushing ranges from 0 to 62%, following flossing from 0 to 41% and following subgingival irrigation from 0 to 50%. This systematic review was designed to assess the influence of oral hygiene, gingival and periodontal status on B-EOA.

Initial evaluation included 290 potential studies. Of those, 12 were judged as eligible for inclusion, and only 1 trial evaluated bacteremia following flossing (B-flossing). The hypothesis tested was that oral hygiene, gingival or periodontal status represent risk factors for development of B-EOA. Meta-analysis could only be completed on the toothbrushing studies because 4 of the 7 B-toothbrushing studies that met inclusion criteria reported similar outcome measures for plaque and gingivitis. Scores from plaque and gingival indices ranged from 0 to 3. Results were compared using 2 categories of gingivitis scores: 0 to 1.5 and  $\geq 1.5$  to 3.0. Although 5 of the 7 articles found no statistically significant associations between oral hygiene, gingival or periodontal status and the prevalence of B-toothbrushing, the meta-analysis showed a significant influence of the plaque and gingival indices (0 to 1.5 and  $\geq 1.5$  to 3.0) on the prevalence of B-toothbrushing. The difference could be in the treatment of the scores as 2 categories or the increased power that comes from larger numbers of subjects when samples of several studies are combined. Additional studies of B-flossing are warranted because flossing is challenging for patients, irregular flossing is assumed to result in bacteremia and soft tissue trauma is the most common harm from improper flossing.

Anecdotal reports indicate that medical and dental professionals recommend that patients with medically compromised or immunocompromised status refrain from flossing to prevent bacteremia or emphasize meticulous oral hygiene on a daily basis to reduce bacteremia intensity. The findings of this systematic review would seem to support the latter because there are no data to evaluate the relationship between oral hygiene, gingival and periodontal status and flossing. There are data to support a relationship with toothbrushing indicating that lower plaque and gingivitis scores are correlated with less prevalent bacteremia.

## The Bottom Line

Each of these studies addressed safety and/or effectiveness of flossing as an adjunct to toothbrushing. Dental hygienists frequently recommend daily flossing to their patients. According to the CDHA position paper, previous research studies have shown that

floss holders, interproximal brushes, wooden sticks and power flossers are effective adjuncts to toothbrushing for interdental cleaning.<sup>1</sup> The paper emphasizes that success of interdental cleaning depends on ease of use and patient motivation, or whether the patient will use the suggested flossing method. Studies also have shown flossing to be less effective where there has been interproximal recession and embrasure spaces are larger.

Both of these systematic reviews and meta-analyses provide clarification regarding the value of flossing for our patients. Based on the findings of these studies, the following conclusions can be drawn:

- For adults, flossing is an effective adjunct to toothbrushing for reducing gingivitis
- There is not sufficient evidence to indicate that flossing significantly reduces plaque beyond toothbrushing alone
- There is no evidence to show that flossing prevents dental caries in adults
- In children, evidence supports only daily professional flossing – evidence supports toothbrushing and fluoride therapy for caries prevention
- There is no evidence indicating that bacteremia following flossing is a concern; however, there is no evidence indicating it is not. Although bacteremia following toothbrushing was related to oral hygiene, gingival or periodontal status, the relationship of bacteremia to systemic health has not been established

## Summary

Evidence indicates flossing is an effective adjunct to toothbrushing in the management of gingivitis but not in the management of dental caries. Evidence is lacking to document whether bacteremia following flossing is related to oral hygiene, gingival or periodontal status. Both of these systematic review/meta-analyses were well designed and provide evidence to clarify the value and safety of flossing. These results combined with former studies suggest that dental hygienists consider the likelihood of patient compliance when recommending floss and other interdental aids and emphasize other interventions such as fluoride therapy for prevention of dental caries. Dental hygienists can confidently make interdental aid recommendations based on patient conditions, abilities and preferences.

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# Critical Issues in Dental Hygiene

## A Center for Oral Health Promotion: Establishing an Inter-Professional Paradigm for Dental Hygiene, Health Care Management and Nursing Education

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### Introduction

Dental hygiene educational settings for students in the U.S. include programs in technical schools, community colleges, 4 year colleges, universities and dental schools. Except for programs housed in the 58 dental schools, the education is provided in separate departments and not integrated with other health care provider disciplines. As a result, students do not learn to view their profession as part of a holistic health care provider approach. In addition, dental hygiene students do not typically practice their educational and clinical skills in a setting where the principles of ideal health care management and nursing care are taught and practiced by students from other disciplines. Similarly, health care management and nursing programs are rarely developed and worked from an integrated scheme. In most cases, health care management students would have their first integration experience when they do their practicums or internships towards the end of the program. Dental hygiene and nursing students would not typically experience collaborative practice education. The ability to effectively interact with other health care professionals will be crucial to the success of health care providers in the future and needs to be addressed in the curriculum.

There are few dental hygiene/nursing inter-

### Abstract

**Purpose:** The need for education about oral health conditions has been discussed in recent years. Current research has shown correlations between oral and systemic disease. Disease entities have been connected to bacteremia and inflammatory processes, both of which can result from oral pathologies. Professionals need to be educated about these connections and advised how, by maintaining proper oral health, they may avoid systemic consequences.

Students in dental hygiene, health care management and nursing programs can play a vital role in this education. By jointly creating and operating an educational Center for Oral Health Promotion, they can better understand each other's professions. This will facilitate developing the skill set to reach out to the underserved and establish protocols to provide health literacy and care at affordable rates. They can also better appreciate the interconnections between health care delivery and its management while gaining skills needed to work in an inter-professional setting.

A Center for Oral Health Promotion would expand services typically offered in dental hygiene educational settings as well as expand dental hygiene, nursing and health care management student experiences.

**Keywords:** Dental Hygienist, Nurse, Healthcare Manager, Inter-Professional Education

This study supports the NDHRA priority area, **Health Services Research:** Determine the extent to which dental hygienists' working in collaborative practice settings with other health professionals or organizations improves the cost-effectiveness and quality of health care outcomes.

professional care programs. New York University Colleges of Dentistry and Nursing have initiated such a program. In 2005 this union was considered an "unusual combination."<sup>1</sup> The 5 dynamic pillars of this partnership include:

- Facilitating interpersonal relationships and mentorships
- Fostering and maintaining an environment for excellence
- Leveraging partnerships among dentistry, nursing and dental hygiene
- Developing men and women of science
- Promoting global activity

The program is based on the concept of increasing the value of every client appointment. Dental hygienists, nurses, physicians, dentists and other allied health providers are compelled to collaborate across disciplines.

The premise of the New York University article is that dental hygiene students work closely with nursing students in planning dental care at the College of Dentistry and to collect risk information on patients/clients. The coordination of patient care is second only to patient-centered care for dental hygiene and dental students. Nursing students take an active role in oral examinations which increases their awareness of optimum oral health. Not only are the students collaborating, the faculty of the programs are collaborating on research. The authors refer to their new program as a one stop shop approach to health care and anticipate that this model would become a national model to improve the outcome of the community's oral and general health.

As a result of the development of inter-professional care programs a survey of Oregon dental hygienists' perception of "their role in inter-professional collaboration, the barriers to effective collaboration and communication skills needed to better participate in inter-professional collaboration" was recently published.<sup>2</sup> The results of the study indicated that hygienists' perception of their role in inter-professional collaboration is valuable. Insufficient time and knowledge of medical diseases were reported as the barriers to effective collaboration. The respondents indicated that leadership skills, speaking and listening were communication skills paramount to participation in inter-professional collaboration.<sup>2</sup>

The authors of the Oregon study contend that medical professionals routinely use inter-professional collaboration in their medical decision making. Due to the oral/systemic connection, there is a need for an ever increasing collaboration among the dental and medical professionals.<sup>2</sup>

Regarding collaboration, "interdisciplinary education needs to become the expected standard in dental and medical education" and "continued

education in medical conditions that have a strong correlation to dental disease such as diabetes, cardiovascular disease and pregnancy may increase dental hygienists' knowledge and consequently increase their confidence in collaboration."<sup>2</sup>

An oral health care model to teach inter-professional education is needed. A Center for Oral Health Promotion would address the need to provide dental hygiene and nursing students with more extensive practical inter-professional experience and introduce them to the business side of health care delivery. The center would at the same time allow health care management students to have extensive contact with providers and afford them the opportunity to become acculturated to the delivery side. The proposed center, therefore, has 2 basic underpinnings: the need to have student practitioners and managers learn in an inter-professional practice setting, and further understanding of the relationship between oral and systemic health issues. This latter application will position health care provider students to better appreciate the clinical aspects of health care delivery and to understand how inter-professional approaches can produce cost savings. Clearly, one of the major challenges that health care providers will face is the need to develop strategies to produce less costly health care delivery. A major impetus in this regard could be the better usage of inter-professional paradigms.

**Oral Health and Systemic Health:** The need for a Center for Oral Health Promotion from a pure health perspective is best recognized by an understanding of the importance of oral health, particularly as it relates to systemic health. The relationship between the 2 begins with the creation of inflammatory processes that typically result from periodontal disease. Studies have shown that the risk for cardiovascular disease may increase as much as 20% in the presence of periodontal disease, and the risk for stroke appears to be even greater.<sup>3</sup> The inflammatory process may be assisted by the causative bacteria infecting atherosclerotic lesions after they have been developed. This further promotes inflammation and underscores the systemic sequelae of periodontitis.<sup>4</sup>

Diabetes diagnoses are becoming more prevalent in our population.<sup>5</sup> The relationship between periodontitis and diabetes works both ways, namely, periodontitis is a major complication of diabetes and periodontitis increases the risk of poor glycemic control in diabetics.<sup>6</sup> The probable explanation for greater existence of periodontitis in diabetics is that diabetes itself tends to increase the susceptibility to infection and the disease also

impedes the utility of immune cell mechanisms that control infection.<sup>7</sup>

Other prevalent health care issues existent in the U.S. involve pregnancy and subsequent delivery. Specifically, the issues of premature births and low birth weights are highly consequential and have been linked to periodontal diseases. Periodontal disease has not been associated as the only factor producing these outcomes, but has been demonstrated to be highly correlative.<sup>8</sup> This finding is especially important for practitioners in states such as Georgia, because Georgia ranks highest in the U.S. with 9.5% of its births classified as low birth weight. This compares to the national average of 8.2%.<sup>9</sup>

Currently, 75% of adults in the U.S. have undiagnosed periodontal disease.<sup>10</sup> The bacterium found in periodontal disease has been linked to systemic health problems such as osteoporosis, coronary heart disease, low birth-weight babies, diabetes, respiratory disease and kidney disease.<sup>11</sup> The Center for Oral Health Promotion would provide education concerning these risk factors, and further offer nutritional counseling addressing the risk factors associated with obesity and provide tobacco cessation programs.

**Services Offered in the Center for Oral Health Promotion:** In the proposed Center for Oral Health Promotion model, clients would be offered preventive dental care by dental hygiene students and provided instruction on the connection between oral health and systemic health. The dental hygiene students would also conduct risk assessments of patients relative to their systemic health from oral health assessments. The center would be managed and promoted by students in the health care management program. Students from the nursing program would play a key role in health assessments and monitoring of determinants of health status and prescription compliance. Nursing students would provide health literacy education to clients.

The center would provide services to children and adults. As prescribed for an adult or child, services would include oral examination, cancer screening, evaluation of vital signs, dental charting, periodontal screening, sealants, radiographs, dental prophylaxis or scaling and root debridement, fluoride treatment, desensitizing treatment, nutritional counseling and individualized home care instructions. Where appropriate, the dental hygiene students would also counsel in the use of mouth guards to prevent potential sports injuries and bite guards for bruxism.

The center's oral health education program would improve the knowledge of patients by educating them on the standards related to good oral and systemic health. Dental hygiene students would provide oral health literacy education and learn to become an "Oral Health Coach" – someone who would direct and help strategize a plan in collaboration with patients based upon their personal oral health goals and immediate dental health needs. The coach would give individuals and families the background information needed to make informed decisions about their oral health.

A review of the literature revealed no relevant information on oral health coaching. The sources found dealt with coaching as it relates to athletics and traumatic dental lesions and mouth guards and a longitudinal study on smokeless tobacco cessation for collegiate baseball players.<sup>12,13</sup>

Nursing students would learn to become a health coach. A search of "health coaches" resulted in articles on health coaches for lower risk of cardiovascular disease and diabetes and employers providing health coaches for their employees to fuel workplace productivity.<sup>14,15</sup> The functions of the oral health coach and the health coach related to oral health will be further developed in the center.

**Comparison of the Fee Survey Results:** While oral health and preventive care is vital for overall systemic health, access to dental care and oral health literacy is not feasible for an increasing number of Americans. For some, it means living in an area with no physical access to dental health care providers. For many, the access challenge is economic. According to the American Dental Association, a large percentage of Americans lack dental insurance and cannot otherwise afford treatment. While there are federal programs designed to provide dental health care to those in need, they are severely under funded.<sup>16</sup>

The vision for a Center for Oral Health Promotion is to meet the needs of both students in the health care education system and the local community they serve. A goal in support of this vision is to provide needed preventive oral health care to the community, particularly for those who require an economic alternative to the typically higher fees of conventional providers. To assess fees for preventive dental services in support of the proposed center concept, a survey was mailed to 57 dentists in a local county as well as to 2 adjoining counties. The survey listed dental procedures within the scope of dental hygiene practice and requested dentists to provide their fees for these



Table I: Comparison of Survey Fees to Proposed Center Fees

Procedure	Survey Average Fees	Center Fees	Difference	% Difference
Oral Health Screening Exam	\$65.13	\$10.00	\$55.13	85%
Adult Prophylaxis	\$ 94.99	\$35.00	\$59.99	63%
Child Prophylaxis	\$83.84	\$20.00	\$63.84	76%
Adult Full Mouth Radiographs	\$102.54	\$20.00	\$82.54	81%
Child Full Mouth Radiographs	\$106.18	\$12.00	\$94.18	89%
BW's Adult Radiograph	\$54.96	\$10.00	\$44.96	82%
BW's Child Radiograph	\$40.07	\$8.00	\$32.07	80%
Sealants (per tooth)	\$45.22	\$10.00	\$35.22	78%
Single Radiograph (per film)	\$26.04	\$2.00	\$24.04	92%
Panoramic Film (with BW's) adult or child	\$87.65	\$25.00	\$62.65	72%
Teeth Whitening Trays/Education	\$385.17	\$100.00	\$285.17	74%
Refills (whitening)	\$57.25	\$50.00	\$7.25	13%
Antibiotic Therapy (each site)	\$45.60	\$10.00	\$36.50	80%
Non-Surgical Periodontal treatment (includes radiographs)	\$626.01	\$125.00	\$501.01	80%
Non-Surgical Periodontal treatment (without radiographs)	\$739.14	\$105.00	\$634.14	86%

Table II: Comparison of Survey Fees to Proposed Center Fees

Procedure	Survey Average Fees	Center Fees	Difference	% Of Difference
Oral Health Screening Exam	\$65.13	\$10.00	\$55.13	85%
Child Prophylaxis	\$83.84	\$20.00	\$63.84	76%
Panoramic Film (with BW's) adult or child	\$87.65	\$25.00	\$62.65	71%
Sealants 4 teeth	\$180.88	\$40.00	\$140.88	78%
Total	\$417.50	\$95.00	\$322.50	77%

services (Figure 1). To improve the response rate, offices which did not respond were contacted by telephone.

Fifteen dental offices replied, yielding a response rate of 26.32%. Results were tabulated and an average calculated. The averages for each procedure were compared to fees from the proposed center (Table I). While one procedure was within \$7.25 of the survey average, the comparison demonstrates significant differences in fees for 93% of the procedures listed. Variations ranged from \$24.04 to \$634.14, with proposed center fees consistently lower. The fee differences indicate a potential benefit for a segment of the population in need of dental hygiene services who do not have the financial means to afford the higher fees charged outside of the center.

All the services provided at the proposed center are important to oral and systemic health, but per-

haps the most valuable in terms of health vs. economic impact is the oral health screening exam. The exam fee at the proposed center is \$10.00 compared to the area average of \$65.13. This represents an 85% difference, a significant economic benefit. With the incidence of undiagnosed periodontal disease being high, the oral exam visit provides significant health benefits relative to cost. The oral health examination entails a thorough evaluation of the patient's dentition, periodontal status and an oral cancer screening. Of potentially greatest value, patient education is also an integral part of the exam visit. The health benefits for some patients will not only be the diagnosis of existing disease, but possibly more importantly, the education the patient receives about how it is to be treated and prevented in the future. For others, the value will be the education received on how to prevent oral disease and the association of oral health to systemic diseases and conditions. Persons receiving care in the center would need to

accept parameters related to lengthened appointment times, frequency of appointments and the need to travel to the center. Staff scheduling care would need to control for broken appointments.

The initial treatment for periodontitis involves non surgical periodontal therapy. As seen in Table I, this procedure can be quite costly. The average survey cost was \$739.14 as compared to the center's fee of \$105.00. This reflects a savings of \$634.14 for a single treatment. However, the treatment for periodontal disease requires a lifetime maintenance regimen with patients often visiting their health care provider 3 to 4 times a year. This multiplies costs for treatment as well as the potential for savings into the thousands of dollars by those choosing to receive treatment at the center. A parent on a limited income with a child having 4 permanent molars would pay a total of \$95.00 at the center for an exam, radiographs, a prophylaxis and 4 sealants compared to an average total of \$417.50 for those dentists participating in the survey. This represents a potential savings of \$322.50 (Table II).

The proposed center would be funded with a combination of hard and soft monies. The hard sources will be funding typically provided to the existing dental hygiene clinic and the fees which will be collected from clients. Additionally, due to this innovative concept related to patient care, grant funding is anticipated.

### **Operation of the Center for Oral Health**

**Promotion:** The Department of Dental Hygiene would partner with the Department of Health Care Management and the Nursing Program to ensure the success of the Center for Oral Health Promotion. Students enrolled in these 3 disciplines would be required to take several courses to assure an understanding of interdisciplinary collaboration. Introduction to Health Care Environment and Principles of Inter-professional Education are courses designed to provide an overview of the environment in health care as well as to introduce the basic principles of inter-professional education. An internship course designed to immerse students in the operation of a multi-disciplinary center would be required and essential to the students' understanding of the services provided by the other disciplines.

Dental hygiene students would provide preventive dental care for the Center's clients. One goal of the Center is to have both dental hygiene and nursing students involved in taking comprehensive health histories and developing a care plan controlling for any findings affecting patient care.

Following these shared experiences, dental hygiene students will focus on outcomes of the oral assessment. Identification of periodontal diseases will allow the dental hygiene students to refer patients to nursing students who would use the opportunity to teach and inform the patients of the possible systemic risks and plan for appropriate care. Patients identified at risk for serious health problems associated with their oral health status will be referred to the appropriate community health care provider.

Students from the nursing program would do health assessments, monitor determinants of health status and work with the patients to ensure that they stay compliant with their medication regimens. In some dental settings, particularly educational ones, patients are often denied care because they exceed dental hygiene clinics' hypertensive limits for blood pressure. In questioning the patients, they frequently admit their increase in blood pressure is attributed to not taking either their diuretics and/or antihypertensive medications. Nursing students would work with these patients as soon as they make an appointment to assure compliance with their medications and collaborate with the dental hygiene students on their findings. This will foster the principles of inter-professional education promoted in the center.

Health care management students would be responsible for the day-to-day administrative functions of the center. Primary functions would involve scheduling of patients and staff and maintenance and ordering of supplies. Additionally, these students would work with local schools, churches, service organizations, clubs and senior citizen centers to arrange preventive oral health services. An important role for these students would be marketing to the community. They would be involved in educating the public regarding oral health and systemic health concerns and informing the community of the oral health education classes and programs available at the center. Financially, these students would play an integral role in seeking funds through grants.

The Center for Oral Health Promotion would offer more than preventive oral care services and systemic health education – it would promote collaborative education among health care professionals and create a model that could be adapted at other universities. The concept would teach dental hygiene, health care management and nursing students the importance of inter-professional collaboration in order to achieve goals for optimal health care services. Together, students

would work with the dental, medical and public health community to provide services to improve oral and systemic health care.

The center would exist in an educational setting, allowing it to be staffed by currently employed staff and faculty and enrolled students in dental hygiene, health care management and nursing programs. One new staff position would be required, the director of the Center for Oral Health Promotion. An overview of the proposed center model includes the following:

#### Staff

- Director – Center for Oral Health Promotion
- Center Receptionist
- Junior and Senior Dental Hygiene students
- Dental Hygiene Graduate students
- Senior Health Care Management students
- Health Care Management Graduate students
- Junior and Senior Nursing students
- Nursing Graduate students

#### Clients

- Men
- Women
- Children

#### Marketing Plan

- Information inserts in area church bulletins
- Presentations at area churches i.e. teens and elder church meetings
- Pamphlets at food shelters
- Pamphlets at civic organizations – Masonic Lodge, Lions Club, VFW Lodge
- PSA on local radio stations
- PSA on local cable channels – local news/public access channel
- Local newspaper – health section
- Local K–12 school newspapers/bulletins
- Flyers to K–12 parents
- PTA presentations
- Flyers in area laundromats and supermarkets
- Flyers on car windshields
- City bus posters
- Posters/flyers in area barber shops, beauty salons & restaurants

This proposed center is a concept designed to achieve better health outcomes in the community and to foster the idea of inter-professional education. If marketing plans are successful and the patient pool increases, staffing needs would be adjusted. This type of success could serve as the impetus to increase the size of the dental hygiene

student cohort. Similarly, articulation agreements with other dental hygiene programs in the catchment area could be pursued.

The health care management students who would administer the center would be responsible for scheduling patients and staff, maintenance and ordering of supplies, marketing to the community and be an integral part of seeking funds through grants.

## Discussion

The need for an educational and oral health care delivery paradigm such as a Center for Oral Health Promotion is demonstrated by the previously discussed correlations between oral health and systemic health and by the socio-economic factors in local counties representing the principal catchment area for this concept. While the presence of a Center for Oral Health Promotion would be a useful addition to health care delivery in any community, its existence in the researched county has an even greater sense of urgency. Two separate, but related factors explain this need: the socio-economic status of its residents and the prevalence of systemic diseases with oral disease connections.

Socio-economic factors existent within the research county have produced a situation whereby both children and adults are underserved in their oral health needs. The ratio of dentists per 1,000 population is 0.46 within the study state, but only 0.18 per 1,000 population in the county studied. Similarly, the statewide ratio of licensed dental hygienists is 0.58 per 1,000 population while in county it is 0.25 per 1,000 population.<sup>17</sup>

Data available for children under the age of 19 enrolled in either Medicaid or State Children's Health Insurance Program (SCHIP) reveal that in the county researched only 37.5% receive any dental services. This compares to a statewide total of 40.7%. The research county had only 41 dentists who actively participated in either SCHIP or Medicaid in 2005 serving a population of 286,517.<sup>17</sup>

The problem of access to dental services in the research county is further exacerbated by income levels. County residents had a median household income in 2006 of \$48,076 compared to the statewide median household income of \$56,112. In 2004, the county had 14.8% of its residents living below the poverty level while the statewide figure was 13.7%.<sup>18</sup>

Within the state studied there exists a significant level of morbidity for diabetes, heart disease and

respiratory diseases, all conditions with previously explained oral health connections. The county unfortunately reflects these patterns. Within the county the morbidity rates in 2006 per 100,000 people was 127.9, for heart disease 1, 219.7; and, for respiratory diseases 573.3.<sup>19,20</sup>

Clearly, within the county a need exists for bridging this gap in health care delivery and the proposed Center for Oral Health Promotion will work to address this need.

## Conclusion

The Center for Oral Health Promotion would provide an inter-professional paradigm for dental hygiene, health care management and nursing education. The need for educational experiences for future health care providers in an inter-professional setting is essential to the future of health care in the U.S. As health care moves to centers housing holistic care, providers must have experience in such environments.

The Center for Oral Health Promotion would provide inter-professional educational experiences, oral hygiene care at affordable fees and education to promote oral and systemic health for the public. In this collaborative setting, students will assess

the health status of patients, deliver dental hygiene services and receive health care management experience. Oral health and health literacy educational programs will also be provided to the public. Additionally, the center will help acculturate health care management students to look at and investigate more economic approaches to health care delivery. With the ever increasing cost of health care, a highly valued asset in managers and providers will be the ability to develop strategies to stem this increase. The center would represent a means of accomplishing this as well as influencing students to develop additional models to effect this transition that provide inter-professional practice experiences to future health care providers.

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# Review of the Literature

## Probiotics for Periodontal Health: A Review of the Literature

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### Introduction

Taking measures to help patients prevent and manage periodontal diseases is a major component of dental hygiene practice. Prevalence of periodontal diseases is difficult to determine accurately, but the most recently released estimate by the Centers for Disease Control and Prevention (CDC) indicates that 8.51% of U.S. adults aged 20 to 64 have periodontal disease defined as at least 1 periodontal probing depth of 4 mm or greater, with 3 mm or more of attachment loss.<sup>1,2</sup> Subsequent examination of this data has suggested that the actual figure may be much higher.<sup>3</sup> It has been reported that more than half of U.S. adults have gingivitis.<sup>4</sup> A combination of specific bacterial activity and the patient's immune response is implicated in pathogenesis of periodontal diseases, causing tissue destruction which can lead to recession, mobility and eventual tooth loss.<sup>5</sup> This article is a review of laboratory and clinical research conducted for the purpose of exploring an emerging treatment option – probiotic therapy to support periodontal health.

A need for new and improved periodontal therapies exists. Dental hygiene practitioners will be familiar with the ubiquity of scaling and root planing as a treatment option for their periodontal patients. Some of the shortcomings of scaling and root planing may be characterized as such: following mechanical removal, periodontal pathogens repopulate pockets within months, compelling continuous and economically burdensome retreatment.<sup>6</sup> There is substantial evi-

### Abstract

**Purpose:** Periodontal disease is common among U.S. adults, and the practice of dental hygiene can be improved by new treatments to control periodontal inflammation and destruction. Probiotics, which are defined as live microbes that confer health benefits to a host when consumed in sufficient quantities, may offer a low-risk, easy-to-use treatment option for periodontal diseases. Experimental probiotic treatments in-vivo and explorations in-vitro published from 2005 to 2010 characterize the effects of specific probiotic strains on factors in periodontal health. Data considered includes clinical parameters such as gingival index, plaque index, periodontal probing depths and bleeding on probing, inhibition versus colonization of known periodontal pathogens and markers of the host immune response. Results of these studies suggest that probiotics may benefit periodontal health. Some of the most promising results occurred when the probiotic treatment was delivered in the form of a lozenge and combined with the traditional treatment of scaling and root planing. Existing commercial probiotic products for periodontal health refer to some of these data. Dosage may also play a role in probiotic efficacy for the periodontium. More research is needed to define the optimal strain or strains, therapeutic dosage, delivery mechanism and patient profile for periodontal probiotics.

**Keywords:** Probiotics, periodontal disease, gingivitis, Lactobacillus, Lactobacillus reuteri, Streptococci, lozenge, chewing gum

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dence that complementing scaling and root planing with antimicrobial chemotherapies, such as antibiotics or Chlorhexidine, improves periodontal healing.<sup>7,8</sup> However, the CDC has identified antibiotic resistance as a growing problem and a direct result of antibiotic use, and reports that "almost every type of bacteria has become stronger and less responsive to antibiotic treatment."<sup>9</sup> Additionally, the

possibility of adverse or allergic drug reaction could make antibiotic therapy for periodontal disease an undesirable option for some patients. Allergy to antibiotics appears to be uncommon, but has been shown to rise in incidence with increasing age and use.<sup>10</sup> A recent review of medical records in San Diego County revealed that out of over 411,000 outpatients given antibiotics in 2007, between 0.5 to 1.1% of men and 1 to 1.5% of women reported adverse reactions, possibly allergic, to non-sulfonamide antimicrobials such as the tetracyclines, macrolides, quinolones and penicillin derivatives sometimes used in treating difficult periodontal cases.<sup>10,11</sup> Chlorhexidine, an antimicrobial agent, has been associated, in some cases, with adverse events in those with poorly controlled diabetes.<sup>12</sup> Thus the search for effective treatment options that offer long-term benefits and pose minimal risk continues. As an alternative, probiotic treatments may not be risk-free — some reports of secondary infection in patients with systemic disease require further analysis — but side effects are considered mild and unlikely. Probiotics have a long history of use in health promotion and are generally considered safe.<sup>13,14</sup>

Dental hygienists are in a position to communicate oral health discoveries to patients, and may encounter questions about probiotics for oral health. A probiotic is defined by the Food and Agriculture Organization of the United Nations and the World Health Organization as a live microbe that confers health benefits to its host, when consumed in sufficient quantity.<sup>15</sup> In recent decades, the targeted use of probiotics to treat diseases has gained popular as well as medical interest. A 2007 review states that since 2000, publications about probiotics increased almost exponentially.<sup>15</sup> A PubMed search yields 559 U.S. based articles about probiotics published in the last 5 years, while a Google search of “probiotics for sale” yields 571,000 results. Commercial probiotic use to promote health is on the public radar.

The efficacious use of probiotics to treat gastrointestinal conditions has been well established.<sup>16</sup> The scientific basis for periodontal application is still emerging, as evidenced by the small body of publications on this topic, but commercial products marketed for periodontal health promotion exist nonetheless. EvoraPlus® products (from Oragenics Inc™, a Biopharmaceutical company based in Tampa, FL) are an example, featuring 3 trademarked strains of *Streptococcus* species.<sup>17</sup> The Swedish biotechnology company BioGaia® (Stockholm, Sweden) is a commercial manufacturer of *L. reuteri* probiotic supplements (“ProDentis®”) marketed for oral health promotion.<sup>18</sup> ProDentis® is distributed in

the United States under the name “Periobalance®” by Sunstar Americas, Inc./G.U.M (Chicago, IL).<sup>19</sup>

Since current research in probiotics may lead to new options for maintaining oral health, the purpose of this review is to evaluate the scientific literature regarding probiotic treatment of periodontal diseases.

## Methods and Materials

Articles were selected for this review from multiple Medline (PubMed) searches, many of which combined the phrases “periodontal disease” or “periodontal diseases” and “probiotics” with other descriptive terms, but also some that substituted specific bacterial names associated with probiotic use and periodontal pathogens in order to maximize the yield of related research. Some articles were selected from the bibliographies of other qualifying and non-qualifying sources. Only articles classified as “clinical trials” (in-vitro or in-vivo, with humans or animal subjects) were included. Other published reviews are not reviewed, but in some cases are referenced for background and supporting information. Peer-reviewed publications between 2000 and 2011 were a criterion for inclusion. Only articles published in English with full-texts available were considered.

The bacteria examined for probiotic use in the articles reviewed were selected from *Lactobacilli*, *Streptococci*, *Bifidobacterium* and *Bacilli* species.<sup>7,20-27</sup> Some of the researchers in these articles examined specific bacterial strains, in accordance with the FAO/WHO guidelines. For example, Teughels et al studied *Streptococcus mitis* BMS, *Streptococcus sanguis* ACTCC 49297, *Streptococcus salivarius* TOVE.7 Mayanagi et al and Shimauchi et al studied *Lactobacillus salivarius*-WB21.<sup>21,22</sup> Twetman et al looked at *Lactobacillus reuteri* DSM17938, ATCC PTA 5289 and ATCC 55730.<sup>23</sup> Staab et al examined *Lactobacillus casei* Sharota.<sup>26</sup>

*Lactobacilli* species were frequently chosen because of their existing uses in targeted probiotic therapy for humans (mainly gastrointestinal) and their otherwise common and often beneficial presence in normal human flora.<sup>20-23</sup> The *L. reuteri* WB21 strain studied by Mayanagi et al and Shimauchi et al, in particular, has been cultivated to survive stomach acids.<sup>21,22</sup> Some researchers point to evidence of *Lactobacilli*'s anti-inflammatory effects in the gastrointestinal tract via mechanisms which could conceivably function in the periodontium as well.<sup>23</sup> Krasse et al were inspired to study *L. reuteri* by anecdotal observations suggesting oral benefits.<sup>24</sup> Teughels et al selected 4 species of *Streptococci*, which are part of the normal oral flora and had previously been shown to possess anti-cariogenic properties, to

examine for periodontal benefits.<sup>7</sup> Zhu et al chose to experiment with a set of strains that they had cultured from commercial yogurt, thus testing the periodontal relevance of bacteria that patients may encounter through usual dietary practices.<sup>25</sup> There is a clear concentration of interest in the available literature around the Lactobacilli, and *L. reuteri* in particular, with 3 out of 10 studies included focusing on that species.<sup>23,24,27</sup>

Each of the in-vivo clinical studies was randomized, double-blinded and controlled, with the exception of one which was not double-blinded.<sup>26</sup> The human sample sizes are generally small, ranging from 30 to 66 individuals. All had a high rate of completion, and no adverse events attributable to the test products were reported in any of the studies.<sup>21-24,27</sup> All of the human subjects were healthy adults. One study collected samples from human subjects, but performed all subsequent experimentation in-vitro and one was completely in-vitro.<sup>20,25</sup> Those performed with human subjects selected participants who were considered healthy apart from some degree of periodontal infection, who were not undergoing active dental treatment (except when scaling and root planing were included in the study design), who did not have concurrent probiotic supplementation, who could tolerate dairy products and who were not undergoing treatment with antibiotics.<sup>20-24,26,27</sup> None of the studies were formulated to specifically examine a smoking population. However, data specific to the subjects who were smokers were considered in 2 studies.<sup>22,26</sup> One study actively excluded smokers.<sup>27</sup> The inclusion of professional prophylaxis and oral hygiene instruction varies from study to study, as does severity of disease in the subjects and sample size. This heterogeneous collection of studies has been reviewed together because of the limited number of sources available for comparison.

The significant findings of these articles are organized within this review by the 3 major categories of results that emerged:

- The clinically observable responses of periodontal tissue to probiotic exposure
- Changes in periodontal pathogen populations in the presence of probiotic bacteria, due to competitive displacement
- Measurable changes in host immune response to probiotic treatment

## Results

**Probiotic effects on clinical signs of periodontal diseases:** Periodontal diseases are characterized by the clinical signs of gingival inflammation and deepened periodontal probing depths, and

generally associated with plaque biofilm formation. The human studies concerning periodontal probiotic treatments invariably collected some data on these parameters.

Krasse et al found that 2 different *L. reuteri* formulations (LR-1 and LR-2, respectively) significantly improved plaque index (PI) scores in subjects with moderate to severe gingivitis compared to similar subjects taking a placebo ( $p < 0.05$  for LR-1,  $p < 0.01$  for LR-2). The LR-1 formulation also significantly improved gingival index (GI) scores compared to a placebo ( $p < 0.0001$ ). The test products were formulated in a chewing gum containing  $1 \times 10^8$  colony forming units (CFU) of *L. reuteri*.<sup>24</sup> Subjects chewed the designated product twice a day after brushing for 2 weeks, and the significant results were recorded at the end of this 14 day test period. The positive effects of both were observed with the use of *L. reuteri* chewing gum on GI and PI, and surpassed the improvements observed in subjects who only received an initial professional prophylaxis and OHI, which all subjects received at the start of the study. Twetman et al, who also tested the effects of chewing gum containing *L. reuteri* strains and recorded PI or GI scores from their periodontally diseased subjects, also measured bleeding on probing.<sup>23</sup> At the 2 week evaluation of these subjects, bleeding was significantly reduced in both test groups but not in the placebo group ( $p < 0.05$ ).

Two research teams at Tohoku University in Japan, Mayanago et al and Shimauchi et al, evaluated the probiotic effect of 1 specific bacterial strain, *Lactobacillus salivarius*-WB21, on the periodontal pathogens in a group of subjects with mild to moderate periodontal disease.<sup>21,22</sup> Sixty-six adult participants were divided into treatment and control groups, statistically similar at baseline. No patients with severe periodontal disease were included, defined as 1 or more periodontal pocket depths of 6 mm or greater (on one of the patient's 6 teeth selected), pathologic mobility or abscess. The test product was a xylitol-based tablet formulated with  $6.7 \times 10^8$  CFU of *L. salivarius*-WB21. Participants were instructed to let the tablet dissolve in their mouths 3 times a day for 8 weeks, but not to alter their usual oral hygiene habits. Shimauchi et al reported that both test groups showed improvements in the clinical indices at 4 and 8 week evaluations, and there were no significant improvements of the test group compared to the placebo group taken as a whole.<sup>22</sup> However, when the non-smokers were ignored and only the smokers from the 2 groups were compared, the test group smokers did show significantly greater improvements in probing depths (PPD) and plaque indices than the placebo-

group smokers at 4 weeks ( $p < 0.05$  PPD,  $p < 0.01$  plaque indices) and at 8 weeks ( $p < 0.05$  for PPD,  $p < 0.05$  plaque indices) of using the experimental treatment.<sup>22</sup>

Staab et al found that the practice of consuming a daily probiotic milk drink containing the Shirota strain of *Lactobacillus casei* did not reduce overall plaque. The product was tested without other modifications over the course of 8 weeks. Unsurprisingly, plaque levels increased even more after a 4 day experimental gingivitis period, during which the subjects ceased plaque removal practices but continued consumption of the drink. The test subjects showed a greater plaque increase than subjects who consumed none of the probiotic drink, possibly due to the carbohydrate content of the test product. Papillary bleeding on probing, however, increased for both groups but remained statistically similar between groups at all data points.<sup>26</sup>

Vivekananda et al found that scaling and root planing a *L. reuteri* lozenge treatment showed significant improvement in all clinical parameters, including clinical attachment, plaque levels, gingivitis (as measured by GI) and bleeding ( $p = 0.001$ ).<sup>27</sup> Scaling and root planing combined with the *L. reuteri* strains was more effective than either treatment alone. This study used a split-mouth design in the test group in addition to a placebo-controlled comparison group. Both the test and placebo groups received scaling and root planing treatment in only half of the mouth and none in the other half. Thus, each subject served as his or her own control. Even in the halves of the mouths that were not treated with scaling and root planing, the active-lozenge group showed a significantly lower plaque index than the placebo group ( $p < 0.001$ ). Meanwhile, the un-scaled quadrants of the placebo group did not show a significant improvement compared with baseline values for these sites. The largest reduction in pocket depth, by 1.31 mm, was also found among the sites that received combined treatment of scaling and root planing plus the *L. reuteri* strains. However, neither scaling and root planing nor *L. reuteri* treatment alone provided even half of the combined improvement.<sup>27</sup> The 30 adult subjects were considered to have chronic periodontitis based on clinically evident gingivitis, 5 to 7 mm probing depths and radiographic bone loss. The test group's lozenges contained  $1 \times 10^8$  CFU of each of the *L. reuteri* strains DSM17938 and ATCC PTA 5289. Subjects in this study waited 3 weeks after scaling and root planing to begin using the lozenges, and continued to use the lozenges twice daily for 3 more weeks.

Of the studies that evaluated clinical parameters,

subjects who received lozenge and chewing gum delivery systems showed significant improvements, especially when the treatment was combined with traditional mechanical therapies.

**Periodontal pathogens:** Many of the studies reviewed examined the potential probiotics' interaction with specific periodontal pathogens. Pathogens in these examinations included *Actinobacillus actinomycetemcomitans*, *Aggregatibacter actinomycetemcomitans*, *Aggregatibacter actinomycetemcomitans* [sic], *Prevotella intermedia*, *Prevotella nigrescens*, *Porphyromonas gingivalis*, *Porphyromonas gulae*, *Porphyromonas circumdentaria*, *Treponema denticola*, *Tannerella forsythia*, *Campylobacter rectus*, *Fusobacterium nucleatum*, *Peptostreptococcus anaerobius* and *Bacteriodes fragilis*.<sup>7,20,22,25,27</sup>

Mayanagi et al, looking for periodontal benefits from *L. salivarius* WB21 consumption, isolated 5 periodontal pathogens from the supragingival and subgingival plaque of all subjects and then evaluated quantitative changes in pathogen colonies over the 8 weeks of the study.<sup>21</sup> No adjunctive treatments, such as scaling and root planing or oral hygiene instruction, were provided. The 5 pathogens identified, using DNA amplification, were *Aggregatibacter actinomycetemcomitans*, *P. intermedia*, *P. gingivalis*, *T. denticola* and *T. forsythia*. By the fourth week of using the *L. salivarius* WB21 tablets, plaque from the test group yielded significantly reduced total bacterial levels of the 5 pathogens ( $p = 0.012$ ). However, when bacterial counts of each pathogen were examined individually and differences among patients, such as baseline bacterial presence, plaque levels and smoking status, were considered, only counts of *T. forsythia* were significantly different between the test and placebo-controlled group ( $p < 0.001$  at 4 weeks,  $p = 0.006$  at 8 weeks), with lower subgingival *T. forsythia* counts in the test group.<sup>21</sup>

In a canine model, Teughels et al examined whether the introduction of 3 *Streptococcus* species, *S. salivarius*, *S. sanguis* and *S. mitis*, could inhibit re-infection of periodontal pockets after scaling and root planing. The 3 infectious pathogens considered were *P. intermedia*, a known human periodontal pathogen, *Porphyromonas gulae*, which has been considered a canine equivalent of *P. gingivalis* and *C. rectus*. Microbial composition was compared in artificially created periodontal 5 mm pocketing. Only when the scaling and root planing treatment was followed by 3 separate insertions of a pellet containing live *Streptococci* probiotics directly into the periodontal pocket, 1 or 2 weeks apart, were lowered pathogen levels maintained



12 weeks after the initial treatment ( $p < 0.001$  for black-pigmented species and  $p = 0.002$  for anaerobic species). In comparison, animals who received scaling and root planing but no probiotics showed significantly reduced black-pigmented pathogen levels after treatment, but the reduction was not sustained over time ( $p > 0.001$ ).<sup>7</sup>

In their study of the *L. reuteri* lozenge, Vivekananda et al also collected subgingival plaque samples for examination of the microbial composition.<sup>27</sup> From these samples, *Aggregibacter actinomycetemcomitans* [sic], *P. gingivalis* and *P. intermedia* were cultured. Significant reductions in the levels of all 3 red-complex periodontal pathogens occurred only in the active-lozenge group, and the reduction of each pathogen was 10-fold in these instances ( $p$  values ranging from  $< 0.01$  to  $< 0.005$ ). Similarly to the Teughels et al canine study, only sites treated with the probiotic showed significantly reduced pathogen levels in pooled subgingival plaque over an extended period after initial treatment, while sites treated with scaling and root planing alone did not. The combined treatment of scaling and root planing plus ProDentis® showed a more significant reduction of *A. actinomycetemcomitans*, *P. gingivalis* and *P. intermedia* significant than the scaling and root planing plus placebo treatment (*A. a.*  $p < 0.005$ , *P. g.*  $p < 0.005$ , *P. i.*  $p < 0.05$ ).<sup>27</sup>

Krasse et al did not measure pathogen displacement, but did find that their test groups treated with *L. reuteri* experienced a large increase in *L. reuteri* presence in the saliva. Fewer than 10% of test patients in this study were found to be colonized with salivary *L. reuteri* at baseline, but by the end of the 2 week study 65% of subjects receiving the LR-1 formulation and 95% of subjects receiving LR-2 were colonized. In both groups, *L. reuteri* made up close to half of the final bacterial presence in saliva while the placebo group had no *L. reuteri* colonization at any point.<sup>24</sup>

Zhu et al were the only group to examine probiotic inhibition of pathogens in comparison to an accepted antimicrobial chemotherapy, though the study was performed only in-vitro.<sup>25</sup> Chlorhexidine was used as a control for the experimental competition of periodontal pathogens with microorganisms found in yogurt. From a commercial brand of yogurt available in China, they isolated and confirmed 4 live strains of bacteria: *Lactobacillus bulgaricus*, *Streptococcus thermophilus*, *Lactobacillus acidophilus* and *Bifidobacterium*. The researchers then tested inhibition of *F. nucleatum*, *P. gingivalis*, *A. actinomycetemcomitans*, *P. intermedia*, *P. nigrescens*, *P. anaerobius*, *B. fragilis* and *P. circumdentaria* against the yogurt cultures by diffus-

ing yogurt through BHI agar that had been seeded with the selected periodontal pathogens. Since the low pH of yogurt has some potential for inhibiting periodontal pathogens, the researchers controlled for pH by preparing another diffusion using yogurt that had been heat-treated to reduce the microbial content to almost zero. Different combinations of bacteria were inoculated onto the same plates, in controlled chronological variations. Zhu et al showed that active yogurt inhibits all 8 pathogens better than the heated yogurt, but not as well as 0.2% Chlorhexidine, which was used as a control. The pathogens tended to be inhibited when the yogurt cultures were introduced to the medium first. When the periodontal pathogens were introduced first, the yogurt cultures and pathogens grew side-by-side with no inhibition with the exception of *P. intermedia*, which was able to inhibit growth of yogurt cultures *Bifidobacterium* and *S. thermophilus*. When inoculated simultaneously, *S. thermophilus* inhibited the pathogen *P. nigrescens*.<sup>25</sup> Though it is impossible to tell from an in-vitro study how these organisms would behave in a clinical trial, this evidence suggests that rapid inoculation with probiotics in an environment free of periodontal pathogens could act preventatively in the growth, or re-growth, of pathogens. The dominance of *P. intermedia* in this instance reminds us that certain pathogens may have the ability to break through the protective colonization of probiotics. The clinical narrative that would result from these inhibitory wins and losses cannot be described from the non-clinical data.

In-vitro experimentation by Köll-Klais et al suggests that the difference between the normal, non-pathogenic flora of periodontal patients versus healthy patients can be characterized by mode of carbohydrate fermentation.<sup>20</sup> In both healthy and diseased patients sampled, the majority of the flora was comprised of *Lactobacilli* species, which are not considered pathogenic. Known oral pathogens, including *Streptococcus mutans*, *A. actinomycetemcomitans*, *P. intermedia* and *P. gingivalis* were also cultivated from the diseased patients. Some of these *Lactobacilli* species were homofermentative, which refers to their metabolic production of a single by-product, lactic acid. Others were heterofermentative, a categorization that refers to their multiple metabolic by-products. Overall, facultative heterofermentatives (homofermentative bacteria that can alter their metabolism to resemble heterofermentation under certain conditions) were present in higher numbers in the periodontitis patients than in the healthy patients, while the obligate homofermentatives (those that must metabolize using homofermentation, with a limited by-product) were relatively low. *Lactobacillus gasseri*, an obli-



gate homofermentative, was not only among the most prevalent in healthy subjects, but was also much less prevalent in the diseased patients. This reviewer noted from the data that *Lactobacillus acidophilus*, a mainstay of commercial probiotic dairy products, made up less than 10% of the obligate homofermentatives in healthy subjects and 0% in the diseased.

When different combinations of the *Lactobacilli* and oral pathogens collected from the subjects' gingival crevicular fluid were cultured and grown together under appropriate conditions, patterns of inhibition could be observed. When grown together, obligate homofermentative and facultative heterofermentative *Lactobacilli* demonstrated the greatest ability to inhibit the pathogens.<sup>20</sup> The value of this study to the development of probiotic treatments appears mainly to be in understanding the roles of existing flora, without treatment.

#### **Probiotic effect on host immune response:**

In response to evidence that some of the health benefits of probiotics are due to immunomodulatory effects, Shimauchi et al, Twetman et al and Staab et al measured host response to potential periodontal probiotics by way of inflammatory markers.<sup>22,23,26</sup>

Twetman et al primarily evaluated the inflammatory markers present in GCF of otherwise healthy adult periodontal patients.<sup>23</sup> Of 3 treatment groups, which differed by number of probiotic active (A) pieces of gum chewed versus number of placebo (P) pieces chewed, only the A/A group showed a significant reduction in 3 of the inflammatory markers evaluated in this study. TNF- $\alpha$  and IL-8 showed reduction at weeks 1 and 2 during treatment, respectively, and IL-6 was reduced 2 weeks after the treatment was ceased ( $p < 0.05$ ). Every piece of active gum contained 2 live strains of *Lactobacillus reuteri*, ATCC 55730 and PTA 5289, in the quantity of  $1 \times 10^8$  CFU each. Subjects in this study were all given oral hygiene instruction. One possible limitation of the site selection was that none of the sites tested were molar sites and all were buccal. Results showed a decrease in BOP and amount of GCF in all subjects after the 2 weeks of chewing the gums, but only the reduction in the experimental groups, A/A and A/P ( $p < 0.05$ ) was considered significant.

Shimauchi et al<sup>22</sup> chose to measure levels of salivary lactoferrin (Lf) based on evidence published in 2007 by Komine et al<sup>28</sup> that Lf proteins in whole saliva indicate periodontal inflammation. The test group, participating in *L. salivarius* WB21 treatment, showed significantly lower salivary Lf levels at 8 weeks, while the placebo group did not

( $p < 0.01$ ). As previously mentioned, examination of smokers was not the purpose of any of these studies, but when the data were calculated to separate the subjects who smoked from the non-smokers, the change in Lf levels was most pronounced among the test subjects who had also smoked.<sup>22</sup> Staab et al, in the only other study reviewed, specifically addressed the relevance of smoking to periodontal health and reported a balanced distribution of smokers among their groups such that any effects of smoking would not skew the results.<sup>26</sup>

To study the clinical and immunologic effects of *L. casei* strain Shirota consumed as a drink, Staab et al measured the inflammatory markers myeloperoxidase (MPO), Polymorphonuclear (PMN) elastase and matrix metalloproteinases (MMP-3), a host enzyme thought to be involved in periodontal destruction. Among the test subjects who consumed the drink every day for 8 weeks, MMP-3 and PMN elastase levels dropped after the 8 week trial, even though plaque increased. In the test group, MPO did increase over the 8 week trial, but then dipped slightly when measured after the 4 "experimental gingivitis" days of ceased plaque removal. In comparison, the control group's MPO levels, as well as MMP-3 and MPO levels, increased at every time point.<sup>26</sup>

## **Discussion**

The literature reviewed included clinical research since 2001 linking periodontal disease pathogenesis and probiotic treatment. There are many well-documented health benefits of probiotics, including relieving of inflammation and prevention of certain infections and allergies.<sup>29</sup> A 2011 review by Teughels et al provides a more in-depth discussion of the history of probiotic treatments and the mechanistic rationales for applying probiotics to periodontal health.<sup>29</sup> Given the infectious and inflammatory nature of periodontal diseases, combined with the challenges of existing treatments, the search for probiotic periodontal therapy is a reasonable development. In 2002, the FAO and WHO proposed guidelines for regulating probiotics and recommended identifying probiotic candidates by DNA-confirmed strain. The guidelines outline a multiphase empirical approach to establishing a profile of safety, handling and targeted therapeutic use similar to the phases required in drug testing.<sup>16</sup> A review of currently published research indicated that, with regard to treating periodontal diseases, there is room for progress in identifying the most promising bacterial species for probiotic cultivation and the most effective treatment modality. Some commercial probiotic periodontal therapies do already exist. Krasse et al and Vivekananda et al both used products manufactured by BioGaia®.<sup>24,27</sup>

BioGaia® cites the 2010 Vivekananda et al study for support of their product's efficacy.<sup>27,30</sup> Though Vivekananda et al stated no conflict of interest, it should be kept in mind that a publication grant and the test products for this study were donated by the BioGaia® company. At this time, there appears to be no publically available research on probiotic treatments for periodontal diseases conducted in the U.S.

**Discussion of Clinical Signs:** The most extensively published data on periodontal probiotics to date involves Lactobacilli species. Shimauchi et al, Twetman et al, Krasse et al and Vivekananda et al reported periodontal benefits associated with *L. reuteri* treatment.<sup>22-24,27</sup> Krasse et al provided evidence that daily, topical *L. reuteri* treatments (in chewing gum form), adjunctive to professional prophylaxis, could improve gingival health, as measured by plaque and gingival indices.<sup>24</sup> Twetman et al also noted a significant reduction in bleeding on probing in test groups chewing 1 or 2 probiotic-enhanced gums daily containing either the LR-1 or LR-2 strain of *L. reuteri*, which was not seen in the control group ( $p < 0.05$ ).<sup>23</sup> According to Vivekananda et al, an active lozenge containing *L. reuteri* provided a clear benefit.<sup>27</sup> Even without instrumentation, mouths receiving treatments that included the ProDentis® lozenge showed significant clinical improvement over the placebo group in all clinical aspects measured at 6 weeks except 1 (pocket probing depth reduction) ( $p < 0.05$  and  $p < 0.001$ ).

When Shimauchi et al examined use of a *L. salivarius* WB21 tablet by patients with mild to moderate periodontal disease, 3 times daily for 8 weeks, only the current smokers showed significant clinical improvements in probing depth and plaque indices ( $p < 0.05$  and  $p < 0.01$ ).<sup>22</sup>

**Discussion of Periodontal Pathogen Response:** Köll-Klais et al identified significantly higher levels of homofermentative Lactobacilli, a group that includes *L. salivarius*, in periodontally healthy subjects than in an otherwise similar group of periodontally diseased subjects ( $p < 0.05$ ).<sup>20</sup> However, *L. gasseri* was the only individual homofermentative that significantly reflected this tendency for greater prevalence in healthy subjects ( $p < 0.001$ ). When tested for inhibition of the periodontal pathogens *A. actinomycetemcomitans*, *P. gingivalis* and *P. intermedia*, one of the best performers among the naturally occurring Lactobacilli was *L. salivarius*, followed by *L. crispatus* and *L. gasseri*.

Mayanagi et al and Shimauchi et al selected *L. salivarius* WB21 as a potential probiotic because Lactobacilli are common oral flora and the species

*L. salivarius* has been shown to reduce salivary levels of black-pigmented bacteria, such as some periodontal pathogens.<sup>21,22</sup> Mayanagi et al discuss that previous research demonstrates a synergistic relationship between *T. forsythia* and *P. gingivalis*.<sup>21</sup> Therefore, suppression of *T. forsythia* could conceivably help to undermine the pathogenesis of *P. gingivalis*. The authors are encouraged by their finding of *T. forsythia* reduction, along with the 2008 data reported by Shimauchi et al from the same participants, that the WB21 strain could have a future in periodontal disease management and prevention.<sup>21,22</sup> A potential conflict of interest exists in both the Mayanagi et al and Shimauchi et al studies in that the research was funded by Wakamoto Pharmaceutical Co., the same company that produced the treatment and placebo tablets. Two of Shimauchi's researchers were employed by this pharmaceutical company. Participants were also selected from the workers at the factory who produced the tablets.

Xylitol is used as a primary ingredient in many placebo and test products across this selection of studies. Xylitol's inhibition of oral Streptococci, with significance for dental caries, has been well documented.<sup>31</sup> There does not appear to be any published research that describes effects of xylitol on periodontal health, and the anticipation of such an effect is not discussed within these studies. Shimauchi et al used a xylitol base for their probiotic-active and placebo tablets.<sup>22</sup> They reported having observed in their own experimentation that xylitol has no modulating effect on periodontal pathogens by itself; however, xylitol boosts *L. salivarius* WB21's inhibitory effects on the periodontal pathogen *P. gingivalis*. They have not included this unpublished data.<sup>22</sup>

Zhu et al also found evidence for the preventive capacity of periodontal probiotics.<sup>25</sup> At least in-vitro, certain probiotic strains can inhibit the growth of *P. gingivalis* and *P. intermedia* when allowed to colonize first. In theory, guided pocket recolonization after scaling and root planing could be a strategic clinical use of probiotics in dental hygiene practice, when Chlorhexidine or other antimicrobials are contraindicated. Further research to develop a probiotic mixture for post-operative in-office application may someday be able to assist the longevity of pathogen removal in scaling and root planing procedures. An implication of this study is that further clinical research could be rewardingly directed at probiotic treatment of periodontal patients immediately following professional plaque removal.

The results of Vivekananda et al are surprising for their uniformity – Pathogens *A. actinomycet-*

emcomitans, *P. gingivalis* and *P. intermedia* were each reduced by the *L. reuteri* test product, ProDentis®, by the same amount (to 10<sup>5</sup> CFU/ml).<sup>27</sup> The ProDentis®-only treatment showed statistically significant reductions in pathogen levels by the end of the 6 week trial ( $p < 0.05$  to  $p < 0.001$ ), and a comparison of the combined scaling and root planing plus ProDentis® treatment to ProDentis® alone showed no statistically significant advantage to adding scaling and root planing. The combined treatment of scaling and root planing plus ProDentis® still showed the greatest numerical reduction of each species, even though the added advantage was not statistically significant compared to the ProDentis®-only treatment. Vivekananda et al discuss that this finding corroborated others' observations regarding the limited effect of a single scaling and root planing treatment on the long-term reduction of periodontal pathogens such as *A. actinomycetemcomitans*.<sup>27</sup>

Teughels et al sampled dogs rather than humans, and is presently the only study examining the use of oral Streptococci as a probiotic treatment in subjects with periodontal disease.<sup>29</sup> Their successful black-pigmented pathogen control within 4 mm pocketing suggests that the search for periodontal probiotics need not be limited to Lactobacilli. Teughels et al were the only investigators to use an intra-pocket treatment application.<sup>7</sup> This approach bears technical similarity to site-specific antimicrobial therapies, such as Arestin® (minocycline HCL 1 mg) and PerioChip® (chlorhexidine gluconate), which are widely regarded as successful.<sup>32</sup>

**Discussion of Host Immune Response:** Twetman et al reported significant benefits for periodontitis patients chewing a double-dose (2 pieces) of active gum a day.<sup>23</sup> These benefits consisted of significant reductions in the inflammatory mediators TNF- $\alpha$  and IL-8, which are known to be associated with inflammatory tissue damage ( $p < 0.05$ ). Since the group who chewed 1 active and 1 placebo piece (effectively receiving single-dose) did not experience the significant drop in mediators, it appears that the response may be dose-related. However, the authors state that it was too early to establish a treatment dosage based on these findings and considered the study a pilot. Though these subjects only chewed the test product for 2 weeks, Twetman et al performed a follow-up evaluation of the inflammatory marker levels again at 4 weeks (2 weeks after test product use was stopped) and found that the levels had returned to their values at the first measurement, before any treatment.<sup>23</sup> The benefits were not long-lasting after treatment ceased. The authors acknowledged that because gingival crevicular fluid could only be collected in

very small amounts, it's hard to know whether the measurement of inflammatory cytokines, such as TNF- $\alpha$  and IL-8, was accurate.<sup>23</sup> Previous in-vitro research published in 2004 by Ma et al supports *L. reuteri*'s ability to modulate TNF- $\alpha$ , IL-8 and other human inflammatory cytokines.<sup>33</sup> Krasse et al state that the 2 strains of *L. reuteri* they examined, LR-1 and LR-2, may have complimentary host benefits, though the data supporting this assertion, based on their own prior research, are not presented or cited.<sup>24</sup>

Though only the current smokers in the Shimauchi et al study test-group showed significant clinical improvements in probing depth and plaque indices ( $p < 0.05$  and  $p < 0.01$ ), the test group as a whole (smokers and non-smokers) showed significantly decreased levels of Lf ( $p < 0.01$ ). Lf data for the currently-smoking subset of test subjects reflect these significant Lf reductions, but it was unclear whether the non-smoking subset experienced such a benefit when considered separately.<sup>22</sup> *L. salivarius* WB21 may therefore be a periodontal probiotic for smokers, but not necessarily for the non-smokers.

The results of Staab et al suggested modulation of the host's immune response by *L. casei* Shirota in the absence of mechanical plaque removal during "experimental gingivitis."<sup>26</sup> The re-elevation of inflammatory marker (PMN elastase and MPO) and MMP-3 levels after the "experimental gingivitis," while no probiotic was consumed, suggested that the effects on immune response are not lasting. *L. casei* Shirota did not seem to reduce plaque build-up. The key finding was immunomodulation, as demonstrated by altered levels of MPO, MMPs and PMN elastase. Further research on this strain, such as a comparison of delivery systems and a controlled trial contrasting the probiotic to other types of treatment, could expand the profile of *L. casei* Shirota as a probiotic. This study was considered a pilot study due to its limited scope and uncontrolled variables, and more research is needed.<sup>26</sup>

## Conclusion

At this point in time, a dental professional's response to patient inquiries about probiotic treatments for periodontal health should be cautious. While supportive research exists, our understanding of the complex and interconnected factors that must be part of any treatment recommendation is too undeveloped for us to offer such recommendations to our patients yet. Much of the relevant data is very recent, published in 2005 or later. Overall, the results of these clinical and in-vitro studies are encouraging to the development of effective probiotic treatments to help maintain and

possibly help restore patients' periodontal health. However, further experimentation is needed. Periodontal disease severity and other health factors, such as systemic disease and lifestyle choices, are variables that have not been fully explored, and trials to establish the optimal delivery methods and treatment schedule are still needed. Currently, *L. reuteri* and several *Streptococci* species are available in formulations intended to support periodontal health. Other species that possess promising characteristics for probiotic periodontal use have yet to be examined in clinical treatment. Finally,

possible conflicts of interest exist within some of the available studies, particularly the most conclusive clinical trials. A thorough collection of clinical trials from truly independent sources is needed before clinical application can be considered grounded in science.

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## Diabetes Educators' Knowledge, Opinions and Behaviors Regarding Periodontal Disease and Diabetes

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### Introduction

The potential link between oral and systemic health has received much attention in medical and dental circles. Studies have shown potential links between oral health and nutritional deficiencies and periodontal disease in relation to cardiovascular disease, diabetes mellitus, obesity and pre-term low-birth weight babies.<sup>1-5</sup> While more studies need to be conducted before positive associations can be confirmed or rejected, it is generally accepted that the mouth can reflect the effects of systemic diseases.

Theories about focal infection and how it contributes to systemic disease have been discussed since the early 1900s.<sup>6</sup> A 1908 article by Merritt titled *Mouth Infection: the Cause of Systemic Disease* stated that "there is a general disposition on the part of the medical and dental professions to underestimate the relations which exist between an unclean mouth and many local and systemic disorders of grave nature."<sup>7</sup> Originally termed "oral sepsis," it was later termed "focal infection" and defined as a "circumscribed area of tissue infected with pathogenic organisms."<sup>6</sup> The term implied that a focus or lesion of infection existed, was bacterial in nature and was capable of dissemination, resulting in systemic infection.<sup>8</sup> While the role of focal infection was debated throughout the 1900s, the late 1980s saw a resurgence of publications in the dental literature inferring an association between periodontopathogenic bacteria and certain systemic conditions.<sup>9</sup> Methods of systemic involvement regarding focal infection include periodontal bacteria (primarily

Gram-negative) entering the bloodstream through ulcerated epithelium, which can provoke systemic inflammatory and immune responses,<sup>9</sup> or through inflammatory mediators present in the diseased pocket which transfer directly into the systemic circulation.<sup>10</sup> In essence, if the bacteria that have entered the bloodstream find favorable conditions,

### Abstract

**Purpose:** The purpose of this study was to determine certified diabetes educators' (CDE) knowledge, behaviors and opinions about periodontal disease and diabetes.

**Methods:** A 33 item questionnaire was distributed to CDEs who provide counseling and education services to patients with diabetes. Questions were open and closed-ended and Likert-scale. A total of 298 CDEs participated in the survey. Descriptive statistics were utilized.

**Results:** Most (62%) agreed that CDEs need to collaborate with dental professionals in disease management and 84% indicated interest in an oral health component being added to their continuing education. Only 20% felt confident in providing an oral health screening to their patients, while 51% discussed oral health with their patients and 64% said they have referred a patient to a dentist within the past year. Most (79%) have not received formal oral health education.

**Conclusion:** The findings indicate that CDEs are aware of and agree that there is a link between oral health and systemic health and that collaboration with the dental profession would be a positive outcome for their patients, as would oral health topics being added to their continuing education courses. By introducing inter-professional collaboration between dental professionals and CDEs, and adding an oral health component to CE courses, CDEs' ability to educate their patients regarding the oral/systemic link could improve.

**Keywords:** Periodontal disease, periodontitis, diabetes mellitus, certified diabetes educator, inter-professional practice

This study supports the NDHRA priority area, **Health Services Research:** Determine the extent to which dental hygienists' working in collaborative practice settings with other health professionals or organizations improves the cost-effectiveness and quality of health care outcomes.

it is possible for them to colonize in distant sites and form ectopic foci of infection. Inflammatory mediators secreted or shed in the gingival tissues may also transport via circulatory mechanisms and activate remote tissues.<sup>11-13</sup>

The Surgeon General's Report on Oral Health in America states the need to have an oral health infrastructure, wherein all health care providers have the knowledge to discuss oral health with their patients.<sup>14</sup> One of the major links between oral and systemic health is the relationship between periodontal disease and diabetes mellitus. Diabetes has become a world-wide epidemic,<sup>15</sup> while periodontal disease is one of the most common infections in humans.<sup>3,4</sup> Approximately 8.3% of the American population has diabetes, roughly 25.8 million children and adults. Future projections predict 1 in 3 Americans born in the year 2000 will develop some form of diabetes.<sup>15</sup> The American Academy of Periodontology estimates that 75% of Americans have some form of periodontal disease.<sup>16</sup> With these statistics, it is no surprise that Healthy People 2010 relates the importance of individual health in making a healthy society and states as 2 of its objectives: "through prevention programs, to reduce the disease and economic burden of diabetes and improve the quality of life for all persons who have or are at risk for diabetes" and "to prevent and control oral and craniofacial diseases, conditions and injuries and improve access to related services."<sup>17</sup> This is a challenge to health care professionals to work together to give comprehensive care to the patient in relation to oral and systemic disease and especially in the area of periodontal disease and diabetes mellitus.

One of the complications of uncontrolled diabetes mellitus is dental disease includes xerostomia, increased risk of caries, oral candidiasis, periodontal abscesses and periodontal disease.<sup>18,19</sup> Xerostomia results from the disruption in salivary flow due to effects of systemic disease (in this case, diabetes).<sup>20</sup> The reduction in salivary flow in turn may lead to an increase in caries,<sup>21</sup> though there does not appear to be a direct correlation between diabetes mellitus and increased dental caries.<sup>22</sup> In a controlled, cross-sectional oral health study in Switzerland, Sandberg et al found that 53.5% of their study participants with diabetes complained of dry mouth compared to 28.4% of participants without diabetes.<sup>23</sup> The study also showed that patients with diabetes and good glycemic control reported less xerostomia than those patients with poor glycemic control (HbA1c levels above 7.5%).<sup>23</sup> Oral candidiasis can be a result of xerostomia and systemic infections such as diabetes.<sup>20</sup> Candidiasis is an opportunistic infection. When the body's im-

mune system is lowered, as in diabetes, candidiasis is more prevalent.<sup>24</sup>

Both diabetes mellitus and periodontal disease are chronic inflammatory diseases; the relationship that exists between the two is bi-directional.<sup>3,20,21,25,26</sup> In fact, Loe has identified periodontal disease as the sixth complication of diabetes along with the classic complications.<sup>27</sup> In patients with diabetes and poor glycemic control the periodontium is more susceptible to infection, which increases the risk of periodontal disease, as Campus et al found in their case-control study.<sup>28</sup> Periodontal disease in turn can exacerbate the glycemic control in patients with diabetes due to the inflammation of the periodontal tissues. This is believed to be a result of the inflammatory response to periodontal disease. Proinflammatory cytokines produced by periodontal disease aggravate the ability of the body to use insulin and can therefore disrupt the regulation of glycemic levels.<sup>29</sup> According to Taylor and colleagues, subjects with diabetes and periodontal disease have a 6-fold higher risk for worsening of glycemic control over time compared to patients with diabetes who do not have periodontal disease.<sup>30</sup> Collin and colleagues studied the periodontal status of elderly patients with Type II diabetes compared to patients without diabetes. They found that patients with Type II diabetes and severe periodontal disease had HbA1c levels that significantly deteriorated as compared to patients with Type II diabetes without severe periodontal disease. They concluded that there seems to be a correlation between severe periodontal disease and the impairment of metabolic control for patients with Type II diabetes.<sup>31</sup>

Few reports appear in the literature that have assessed health care professionals' knowledge and practice behaviors regarding oral health. Of those that have been conducted, they have focused on obstetricians, nurse practitioners and certified nurse midwives and physicians.<sup>32-34</sup> Findings from these studies show that, though knowledge of periodontal disease has been low, there is keen interest in collaboration with oral health care professionals and a desire for more information about oral health to share with their patients.

Diabetes educators focus on 7 areas when counseling their patients: healthy eating, being active, monitoring, taking medication, problem solving, healthy coping and reducing risks.<sup>35</sup> However, among diabetes educators, there is little research to show their knowledge about periodontal disease and diabetes and how this affects their behaviors in counseling and referring their patients. Yuen et al conducted a study to determine South Carolina

certified diabetes educators' (CDEs') perceptions regarding their preparation to provide oral health information to their patients, what barriers they felt prevented them from including oral health education in their curricula and how adequately the curriculum covered the topic of oral health.<sup>36</sup> The study found that the majority of the diabetes educators had been practicing for a median of 8 years, worked about 25 hours a week and saw a median of 15 patients weekly.<sup>36</sup> Those surveyed were asked to rate the content of their diabetes education curricula regarding its coverage of general and oral health topics. Responses ranged from a low of 0.8% (in response to whether they ask their patients to demonstrate correct brushing and flossing techniques) to a high of 59.2% (in response to whether or not they recommend frequent dental cleanings).<sup>36</sup> The majority responded positively to the addition of an oral health component to their curricula, while 76.9% reported that they did not have an oral health component already in place. Diabetes educators who had an oral health component in their curricula were more likely to recommend frequent cleanings and oral hygiene home care, emphasize the effect of uncontrolled diabetes and periodontal disease and the effect of periodontal disease on diabetes and monitor their patients' oral health (gum health and dry mouth).<sup>36</sup> Yuen concluded his study by encouraging the integration of oral health content in the diabetes education curriculum.

The purpose of this study was to determine CDEs' knowledge, opinions and practice behaviors regarding the evidence between periodontal disease and diabetes mellitus.

## Methods and Materials

The University of North Carolina Biomedical Institutional Review Board approved the study design and instrument. The survey instrument "Diabetes Educators' Opinions and Behaviors Regarding Periodontal Disease and Diabetes Mellitus" was developed specifically for this study and was designed by a multidisciplinary research team and pilot tested by 5 CDEs. The survey was 33 questions in length and was designed to assess the knowledge, behaviors and opinions of CDEs regarding the relationship between periodontal disease and diabetes. In addition, it assessed the demographics and practice settings of CDEs, their knowledge and opinions about periodontal disease and systemic health, their role and comfort level in providing counseling to their patients about periodontal disease and diabetes and oral health education received throughout their training. Some questions were open and closed ended and some used Likert-scale responses. Revisions were incorporated prior

to printing the final version of the survey instrument. The survey was conducted in paper format (Teleform), which allowed answers to be bubbled in for the desired response. These responses could then be scanned directly into an ACCESS database. No other measures of the instrument's validity or reliability were conducted.

The survey sample was recruited from participants attending the 36th Annual American Association of Diabetes Educators' meeting in Atlanta, Georgia in August 2009. Approval for the data collection was obtained from the American Association of Diabetes Educators. Participants in this meeting represented a sample of CDEs from across the nation. Recruitment took place at a booth in the Exhibition Hall of the meeting. The survey was available to all participants at the meeting who were CDEs and who currently provided counseling to patients. An explanation of the purpose and design of the survey was provided to each potential participant. Participants were free to refuse to participate in the study. As an incentive for completion, \$5 in cash was given to each participant upon completion of the survey. No identifying data was associated with the survey – participants remained anonymous. A total of 298 CDEs participated in the study, approximately 10% of the attendees as reported by the AADE.

Descriptive statistics were generated for all study variables and domains.

## Results

**Demographics:** Demographics of the survey participants are illustrated in Table I (n=298). Fifty-eight percent were nurses, 35% were registered dietitians, 2% were pharmacists and 5% were other professionals. The majority of participants (99%) were female and 58% held a nursing degree. Seventy-six percent had been to the dentist in the past 6 months and 84% were told they did not have periodontal disease, with 57% rating themselves as having "good" oral health. Forty-two percent reported working in a hospital practice, while 15% reported working in a specialty office. The mean number of years reported for providing counseling and educational services to patients with diabetes was 15 years. Sixty percent reported spending more than 20 hours a week providing care to patients with diabetes.

**Knowledge:** CDEs' knowledge about periodontal disease and systemic health was high. When asked about risk factors for periodontal disease, the majority recognized the important factors. However, many did not know whether tooth decay was a factor in periodontal disease (Figure 1). Most (84%)

Table I: Demographics of Participants

Variables (n=298)	Nurse		Registered Dietitian		Pharmacist		Other	
	N	%	N	%	N	%	N	%
Age								
25–35	6	2.0	8	2.7	1	0.3	0	0
36–45	25	8.5	32	10.8	3	1.0	6	2.0
46–55	73	24.7	32	10.8	1	0.3	6	2.0
56–65	64	21.7	30	10.2	1	0.3	2	0.7
>65	4	1.4	0	0	1	0.3	0	0
Last dental visit with perio assessment								
≤6 months	111	42.5	72	27.6	6	2.3	8	3.1
>6 months and <1 year	32	12.3	8	3.1	0	0	2	0.8
>1 year and <2 years	7	2.7	7	2.7	0	0	0	0
>2 years	4	1.5	3	1.1	0	0	0	0
Never	0	0	0	0	1	0.4	0	0
Personal oral health								
Excellent	47	18	35	13.4	2	.8	6	2.3
Good	95	36.4	46	17.6	5	1.9	3	1.1
Fair	11	4.2	7	2.7	0	0	1	0.4
Poor	1	0.4	2	0.8	0	0	0	0
Gender								
Male	3	1.1	0	0	0	0	0	0
Female	151	57.9	90	34.5	7	2.7	10	3.8
Diagnosed with periodontal disease								
Yes	22	8.4	11	4.2	2	0.8	1	0.4
No	130	49.8	74	28.4	5	1.9	9	3.4
Maybe	2	0.8	5	1.9	0	0	0	0

could distinguish periodontitis from gingivitis, and realized periodontitis is the worse condition. When asked about the first clinical sign of periodontal disease, 38% answered bleeding gums, followed by 29% who thought it was bad breath. An overwhelming number recognized that people with diabetes are at an increased risk of periodontal disease (99%), that poor glycemic control promotes growth of oral bacteria (99%) and that periodontal disease may worsen glycemic control (97%).

**Attitudes and Opinions:** Attitudes of CDEs regarding the link between periodontal disease and diabetes were reflected in their referral patterns. When asked the average number of patients with whom they discuss oral health, the mean percentage for all those surveyed was 55.7%. Sixty-four percent of CDEs said they have referred a patient with diabetes to a dental office or clinic within the past year. For those who don't refer, the main ob-

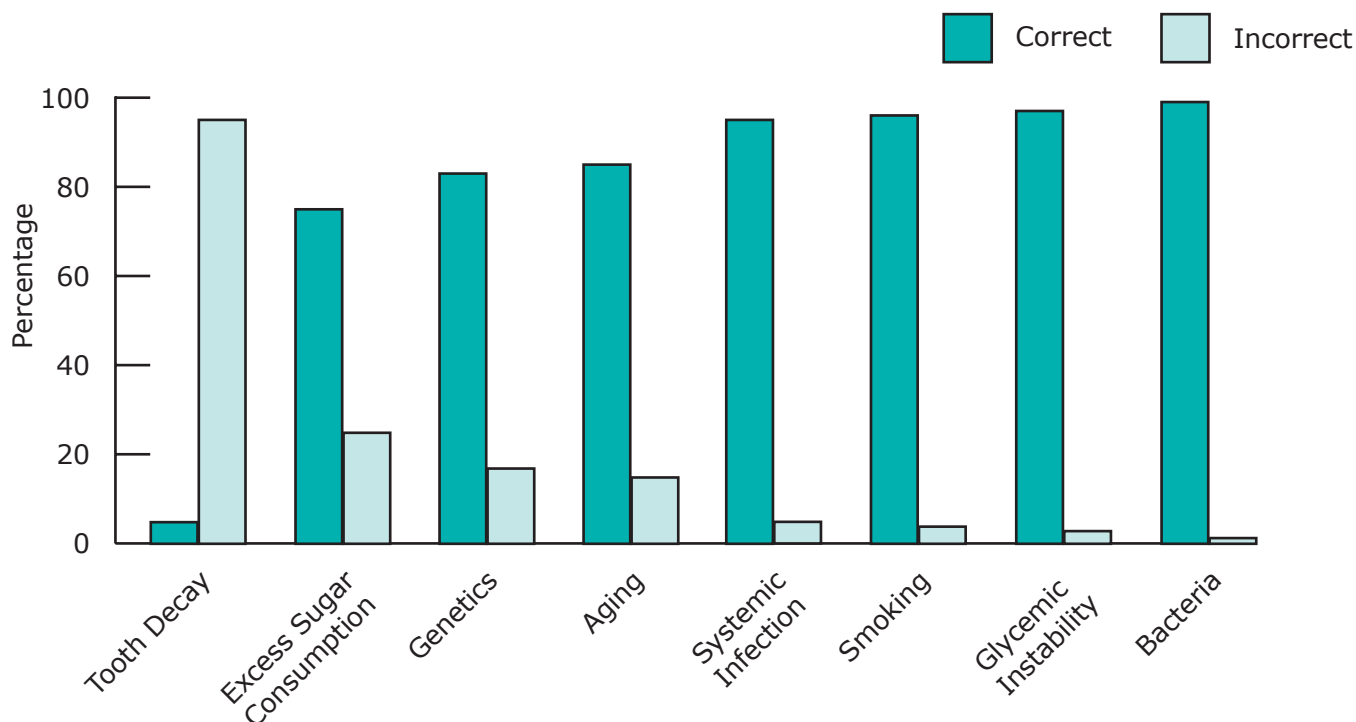
stacles reported were their patients' lack of financial resources for dental care (57%) and their own uncertainty about when to refer (56%).

Opinions of CDEs regarding their own knowledge about the link between periodontal disease and diabetes are included in Table II. Most (44.7%) agreed with the statement "I am knowledgeable regarding the studies linking periodontal disease and diabetes," but felt they needed more information about periodontal disease and its impact on diabetes (88.5%). The majority agreed that CDEs need to collaborate with dental professionals to reduce their patients' risk of developing periodontal disease (96.3%). A large percentage showed enthusiasm for an oral health component being added to their diabetes continuing education (83.8%).

**Education and Training:** Of those surveyed, 79% said they have not received any oral health



Figure 1: Certified Diabetes Educator's Knowledge about Factors Influencing Periodontal Disease



education (didactic or curricular) in their professional training. For the 21% that had oral health education in their professional training, 38% rated that education as fair, while 31% reported theirs as good. Ninety percent reported they had not had any oral health education since receiving their CDE certification. Of the 10% who did report having had oral health education since their certification, 31% indicated this information only covered general information on healthy teeth and gums.

## Discussion

Due to the relationship between periodontal disease and diabetes and the increasing numbers of patients diagnosed with diabetes, it is important to know about the oral health information patients with diabetes are receiving from their counselors. This study sought to determine if CDEs are knowledgeable about the link between periodontal disease and diabetes, and if they provide any oral health counseling to their patients. Results showed that CDEs have a high knowledge of periodontal disease and its impact on systemic health. However, results also showed that CDEs desire more information about periodontal disease and diabetes and they are not sure how to counsel their patients.

**Knowledge about Periodontal Disease and Diabetes:** CDEs appear to be very knowledgeable about periodontal disease and diabetes. Regarding questions asking about factors influencing

periodontal disease, the majority of respondents answered correctly. The majority agreed that if a patient has periodontal disease, they are more likely to have poor glycemic control than a patient without periodontal disease (95%). They also agreed that patients with poor glycemic control are more likely to have periodontal disease. However, CDEs are not confident in screening for periodontal disease themselves. Ninety-six percent agreed that there should be collaboration between dental professionals and CDEs to increase their patients' health. This interest in working with dental professionals shows potential for the oral health infrastructure discussed in the Surgeon General's Report.<sup>14</sup> If both CDEs and dental professionals can collaborate inter-professionally, patients might have the potential to receive better dental and overall care for their condition. The prediction for the future is that the numbers of patients with diabetes will vastly increase,<sup>15</sup> so an increase in inter-professional collaboration and communication will be needed for the care of these patients. Opportunities for providing CE courses for CDEs regarding oral health and systemic complications could further the knowledge and promote working relationships between these groups.

**Counseling and Referrals Regarding Periodontal Disease and Diabetes:** About half of CDEs reported counseling their patients about oral health. Specific questions about the content of this counseling were not asked, however, 31%

Table II: Certified Diabetes Educators' Opinions about Periodontal Disease and Systemic Health

n=298	Strongly Agree		Agree		Unsure/ Don't know		Disagree		Strongly disagree	
The research is inconclusive regarding the relationship between periodontal disease and systemic health	7%	(20)	11.4%	(34)	19.5%	(58)	37%	(110)	25.1%	(76)
I am knowledgeable regarding the studies linking periodontal disease and diabetes	15.8%	(47)	28.9%	(86)	23.8%	(71)	28.9%	(86)	2.7%	(8)
I need additional information about periodontal disease and its impact on diabetes	41.9%	(125)	46.6%	(139)	7.0%	(21)	3.4%	(10)	1.0%	(3)
I am confident that I can provide an oral health screening to my patients with diabetes	19.8%	(59)	19.1%	(57)	30.5%	(91)	24.5%	(73)	6.0%	18
CDE's should be taught to screen for periodontal disease in their patients	49.7%	(148)	30.9%	(92)	14.1%	(42)	3.7%	(11)	1.7%	(5)
CDE's need to collaborate with dental professionals to reduce their patients' risk of developing periodontal disease	62.1%	(185)	34.2%	(102)	1.7%	(5)	1.0%	(3)	1.0%	(3)
I am interested in including an oral health component in my diabetes continuing education	37.2%	(111)	46.6%	(139)	12.1%	(36)	2.3%	(7)	1.7%	(5)

reported receiving only general information about oral health. Therefore, patients may only be receiving general information about healthy teeth and gums and not specific information about their condition and periodontal risks. This is corroborated by Koeber et al, who identified that nurses and nutritionists considered oral health to be important but spent less time focusing on periodontal and systemic issues than on the patient's systemic condition.<sup>37</sup> While the CDEs in this study who reported having received oral health education do not appear more likely to counsel their patients than those who have not received any oral health education, Yuen et al report that having an oral health component in the curricula does influence CDEs' recommendations for frequent scalings, and their emphasis to patients about the effect of uncontrolled diabetes on the periodontium.<sup>36</sup>

CDEs do recognize the importance of referring their patient with diabetes to a dental office. Though they understand the importance of referrals, CDEs appear to be uncomfortable deciding when this referral should take place. This could be due to their beliefs concerning their scope of practice, i.e that nurses and registered dietitians do not believe this to be a part of their scope of practice, or it could be an ethical issue – they be-

lieve it is unethical to make a referral when they are being consulted. Fifty-six percent report not referring their patients because they are unsure of when to refer, and 53% say their lack of oral health training prevents them from making this decision.

**Opinions Regarding Oral/Systemic Research:** CDEs in this study indicated that they believe the research to be strong showing the relationship between periodontal disease and systemic health. However, less than half felt they were knowledgeable about these studies (Table II). Eighteen percent received their oral health information in their professional journals. This finding agrees with Koerber et al who found that nurses and nutritionists reported that the best way for them to receive information about periodontal disease and diabetes would be through guidelines and protocols in their workplaces, or through their professional journals.<sup>37</sup> It is possible that the information about the periodontal/diabetes link may be represented more in dental literature and not in their own journals, which could contribute to their uncertainty about these studies. Eighty-nine percent of CDEs in this study indicated that they needed additional information regarding periodontal disease and its impact on diabetes (Table II).

This information seems to point to a potential demand for oral health information that could easily be provided by the dental academic community or corporate entities.

While knowledge of periodontal disease and diabetes is high, CDEs welcome continuing education courses explaining both the research in this area and how to translate their knowledge into clinical practice. Ninety percent of those surveyed said they have not received any formal oral health education since receiving their CDE. Of those, 31% said the information they received focused on general information about healthy teeth and gums and did not deal with oral/systemic conditions. There is potential for development of a course for CDEs that would provide specific and practical information about periodontal disease and diabetes, and incorporate recommendations on how to educate patients with diabetes. Several dental companies have created oral health education packets focusing on diabetes and periodontal disease. Many of these companies have websites with educational information that may be downloaded. CDEs need to be alerted to the resources available to them. Also, web-based courses or traditional continuing education courses designed to increase inter-professional education and collaboration between nursing, dentistry and medicine might enhance the overall health of patients with diabetes.

Due to the increasing numbers of patients with diabetes and the prevalence of periodontal disease, the authors feel that this report is very timely. Both diabetes and periodontal disease have been a primary focus of medical and dental research and will continue to increase in the future. With the increased emphasis for medical and dental professionals to work together in a more collaborative way, the results of this study show that one group in particular, CDEs, are very receptive and eager to participate. It is anticipated and desired for prevention strategies to gain increased support in the future as the national health care debate continues. CDEs primary focus is to counsel and educate patients with diabetes about preventive strategies for a better quality of life and by offering some suggestions for inter-professional collaboration. The authors hope that CDEs and dental professionals alike will partner together to help their patients with diabetes. As dental curricula are modified to include inter-professional

education and collaboration with medical providers and educators, CDEs should be included.

The findings in this study reflect the need for further studies to determine the best methods to use to educate CDEs about periodontal disease and diabetes. Methods of data collection could include a continuing education course or focus group format to discuss the specifics of periodontal disease and diabetes, the research findings and how to translate the information into patient education. Results may make a difference in the confidence of CDEs in providing oral health counseling to their patients. Further studies could be conducted to determine if increased oral health information provided to CDEs has an impact on their patients with diabetes.

## Conclusion

CDEs are very knowledgeable regarding periodontal disease and its impact on diabetes. They realize the importance of referring their patients to the dental office and are interested in collaborating with dental professionals. They agree with the current literature showing a potential link between diabetes and periodontal disease, however, many CDEs indicated they do not feel knowledgeable about these studies. The majority indicated they would appreciate continuing education courses explaining how to educate their patients and when to refer to a dental professional.

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## Dimensions of Oral Care Management in Texas Hospitals

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### Introduction

The oral and systemic health connection is becoming clearer every day. Oral health is needed to achieve overall health, especially for individuals who have been hospitalized.<sup>1,2</sup> Oral health problems can exacerbate their medical status and vice versa. Most importantly, improving their oral health may actually prevent hospital-acquired conditions (nosocomial) and/or improve their overall health.<sup>3,4</sup> Many also need specialized oral care, such as patients who have mechanical ventilation. Finally, when they leave the hospital, these individuals may need a referral for follow-up oral care to maintain their health.

Nurses are the logical professional for providing oral care in the hospital, because they assess the health status of their patients on a regular basis. However, sources indicate that nurses do not receive much training in oral care management and might not consistently provide adequate oral care for their patients,<sup>5</sup> and most hospitals do not employ dentists and/or dental hygienists to provide oral care. Although the literature reveals some information about the education of nurses and the knowledge and practices of some areas of hospital nursing, there has been no broad assessment of their knowledge, attitudes and practices. Since it is not known if nurses are providing oral care and if they have sufficient knowledge for doing so, the

### Abstract

**Purpose:** There is a growing body of evidence that suggests improved oral health can help patient outcomes in hospitals. Yet there are indicators that oral care in hospitals is less than ideal. This study was conducted to quantify and qualify the dimensions of oral care in Texas hospitals with a focus on the dental knowledge, attitudes and practices of nurses and barriers to providing such care.

**Methods:** A random sample of 582 registered nurses, licensed and employed in Texas, was surveyed about oral care attitudes, practices and knowledge. Frequencies and Spearman correlations were used to describe and analyze the data with SPSS.

**Results:** Ninety-eight respondents returned surveys for a 16.8% response rate. Of these, 52% reported their nursing education did not ("minimally/not at all") prepare them for oral care management. However, they felt oral health was important (95%), felt responsible for oral care (79%) and assessed the oral cavity of their patients (78.6%). Although they reported being "knowledgeable" or "very knowledgeable" about oral health management (67%), their score on the knowledge questions was low (mean=51%, sd=0.132). There was not a significant correlation between the knowledge scores and education levels ( $p=0.136$ ,  $p>0.05$ ) or knowledge scores and work areas ( $p=-0.080$ ,  $p>0.05$ ). They also reported such barriers as low priority for oral care, lack of time, no mandate and the need for more resources.

**Conclusion:** This study revealed that nurses experienced a disconnect between feeling responsible yet somewhat incapable and/or ill-prepared to provide adequate oral care for their patients. This suggests a possible need for revising nurse education, hospital requirements and protocols for performing oral care and employing dental professionals in hospitals.

**Keywords:** nursing education, nurse practice patterns, inter-professional practice, hospitals, hospital administration, dental hygiene, oral health, dental care, assessment- patient outcomes and outcomes research

This study supports the NDHRA priority area, **Health Services Research:** Determine if differences exist in patient outcomes and costs for a given oral condition when services are provided by dental hygienists vs. other.

question of whether this vital need is being met in hospitals needs to be addressed.

**Oral and Systemic Health Connection:** The report of the Surgeon General clarified the role of oral health in maintaining overall health. Beyond healthy teeth, oral health includes being free of chronic oral–facial pain, oral and pharyngeal cancers, oral soft tissue lesions and birth defects, such as cleft lip and palate. The mouth is a mirror to the health of the body. An analysis of saliva can provide telltale clues of overall health or disease. The mouth can also reveal nutritional deficiencies, microbial infections, immune disorders, injuries and some cancers. Oral problems can also affect the health of the body. There is new evidence about associations between chronic oral infections and heart and lung diseases, stroke and low–birth–weight, premature births.

The U.S. Oral Health Workforce in the Coming Decade report further describes these associations between oral and general health.<sup>2</sup> Diabetes mellitus causes increased tissue destruction in diabetics with periodontitis, and periodontitis exacerbates glycemic control in diabetic patients. Diabetics who receive periodontal care have lower medical costs. A lesion in the mouth may be the first indication of HIV infection. In the future, saliva may be used to monitor chronic disease by measuring medications, hormones, environmental toxins and antibodies. Finally, oral cancer results in 8,000 deaths per year, and early detection is vital.

Many medications cause xerostomia, as well as radiation and chemotherapy treatments.<sup>6</sup> Medication classes that may decrease salivary flow and cause xerostomia include antidepressants, diuretics, anticholinergics, antihistamines and opiates.<sup>7</sup> In addition to discomfort, the lack of saliva can negatively affect overall health, because saliva has antibacterial properties and plays a role in the body's defense against infections.<sup>8</sup>

Oral care interventions have been shown to improve the overall health of hospitalized patients. A leading cause of death in intensive care units (ICUs) is ventilator–associated pneumonia (VAP). VAP occurs in 9 to 28% of patients that are treated with mechanical ventilation, and mortality rates range from 24 to 50%.<sup>9</sup> This hospital acquired or nosocomial pneumonia is usually caused by aspirated bacteria that do not normally colonize in the oropharynx. Scannapieco et al conducted a systematic review of 36 studies to determine if oral hygiene interventions reduce the rate of pneumonia in hospitalized and nursing home patients.<sup>3</sup> One main result was that mechanical and/or topical chemical disinfection reduced the incidence of nosocomial pneumonia by an

average of 40%. These interventions included topical antibiotics, chlorhexidine and iodine, as well as tooth brushing.

Oral mucositis can affect up to 100% of patients undergoing chemotherapy with hematopoietic stem cell transplantation (HSCT) and 80% with head and neck malignancies receiving radiotherapy. The signs and symptoms include erythema, edema, burning sensation, sensitivity to hot and spicy food and white patches on the mucous membranes (which become painful ulcers), the latter causing intense pain and difficulty in swallowing, speaking and eating, leading to malnutrition and dehydration. These ulcers can become infected, and this progression can delay the medical treatment plan, contribute to increased hospital stays and increased costs for care.<sup>10,11</sup> In a controlled clinical trial on 70 HSCT patients, de Silva Santos et al demonstrated that enhanced oral care reduced the duration of mucositis.<sup>11</sup> In a longitudinal study of 53 HSCT patients, Soga et al demonstrated that an intensive oral care regimen actually reduced the prevalence of mucositis from 75 to 20%.<sup>4</sup>

**Specialized Oral Care:** Many hospitalized patients need specialized oral care. Orally intubated patients need daily cleaning of all oral surfaces with a toothbrush or sponge–tipped swab. Saline solution, mouthwash or chlorhexidine may be used as cleansing agents, followed by suction removal. The patient's airway must be protected to prevent aspiration, and the endotracheal tube must be stabilized (this may require using an assistant). Lubricants should be applied to the lips, and the endotracheal tube tape should be changed if it is loose or contaminated.<sup>7</sup>

Others needing specialized care include organ transplant and oncology patients undergoing chemotherapy or radiation therapy. For these, all possible sources of oral infection are taken care of prior to treatment, including extractions, restorations and periodontal therapy. Side effects such as xerostomia and mucositis need to be managed during therapy, and oral health needs to be constantly monitored after treatment. For the patients undergoing radiation therapy, strategies need to be in place to prevent osteoradionecrosis.<sup>12</sup>

**Oral Care Knowledge, Opinions and Practices of Nurses:** Nurse education is medically oriented, and oral health education has a low priority.<sup>13–15</sup> In a survey of nursing students, McAuliffe found that 76% had only 2 to 3 hours of oral care education.<sup>16</sup> Miller and Rubinstein surveyed Baltimore nursing students about their oral care knowledge and practices.<sup>5</sup> The majority knew about plaque and its relationship to caries and gingivitis, but less knew how

to clean dentures, the best type of toothbrush and the role of toothpaste. They also did not know the appropriate way to brush and floss and how quickly plaque returned to the oral cavity.

Improving the education of nurses could improve their oral care practices. Furr et al conducted a national study to investigate how hospital factors, nurses' background, education and attitudes influenced the quality of oral care in ICU.<sup>17</sup> They found that the following factors directly affected the quality of care that nurses provided: education in oral health, having enough time for oral care, having a higher priority for oral care and not perceiving oral care as unpleasant.

Regarding attitudes, Paulsson et al found in a qualitative study that nurses viewed oral care as very important for their own health and for their patients.<sup>18</sup> They understood the link between good oral health and overall health, and they seemed motivated to help the care receivers with their needs and desires regarding oral care. In a study of ICU nurses by Binkley et al, over 90% reported that nurses should be responsible for cleaning the oral cavity of their intubated patients.<sup>19</sup> The majority also wanted to learn more about oral care, although only about one third were interested in attending a continuing education workshop in ICU oral care.

Lack of time and the stress of trying to keep the critically ill patients alive lower their priority for oral care.<sup>6,20-22</sup> In a survey of nurses by Adams, lack of time was the number one reason for not performing oral care.<sup>23</sup> Other influences were doing it "the way it has always been done here" and/or the views of the nurse manager towards dental care.<sup>18,24-26</sup> In McAuliffe's survey of nurses, the majority agreed that "fitting in" and being a part of the ward were important to them, as well as adopting the oral hygiene practices of the more qualified nurses in the work place.<sup>16</sup>

Studies indicate that oral care practices are deficient or inconsistent in hospitals. A recent survey of nurses at the Children's Medical Center in Dallas found that only 27% reported "always" performing oral evaluations on patients.<sup>27</sup> Kinley and Brennan studied a palliative care unit and found that only 21% of the staff reported looking in the oral cavity on admission.<sup>28</sup> Only 28 to 56% of patients had a documented oral care assessment and only 10% had documentation about receiving oral care advice.

Certain factors have been identified as affecting hospital oral care practices. In a survey by Costello and Coyne, most of the nurses reported a lack of

toothbrushes and toothpaste.<sup>21</sup> In the Binkley et al study, 46% felt they needed better supplies, such as chlorhexidine or pre-packaged oral care systems.<sup>19</sup> These systems may include toothbrushes, suction swabs, pliable suction catheter to remove oral secretions and clear mouth moisturizer with aloe vera gel. Oral assessment guides provide detailed, step-by-step procedures for assessing the health of the oral structures, but they are not being used with much frequency.<sup>27,29</sup> Lack of hospital standards for oral care can affect nurse practices. In 2 studies, the implementation of standard protocols and tools for oral care increased the quality and frequency of such care, as well as improved patient satisfaction.<sup>19,28</sup>

All hospitalized patients need oral care and certain types of patients need very specialized care. Oral care interventions also improve the health of hospital patients. The purpose of this study was to quantify and qualify the dimensions of oral care in Texas hospitals. The specific research questions were as follows:

1. What was the knowledge level of nurses regarding the oral care of their patients?
2. What were their opinions about providing oral care?
3. What were their practices for assessing and providing oral care?
4. What factors affected their oral care practices?

## Methods and Materials

**Sampling Strategy:** The participants in this study were registered nurses currently licensed and working in Texas hospitals. These nurses worked in the following specialty areas: home health, intensive/critical care, pediatrics, psychology/mental health, oncology, rehabilitation, general practice, geriatrics and medical/surgical. The participants were identified through the Texas State Board of Nursing website ([www.bon.state.tx.us](http://www.bon.state.tx.us)), which contains the specialty area of work, address, Texas County or state where the nurse currently works, license number, status and when it was issued. There were 390,000 registered nurses on this list, and the target population was the 57,563 currently employed in hospitals. The website data was sent to the investigator on a compact disc.

From this target population a probability, random sampling was used to select 382 nurses, the sample size calculated by Dillman's formula for an error rate of 0.05 and a 95% confidence level.<sup>30</sup> Because this formula assumes a 100% response rate, the sample size was increased to 637. SPSS was used to select 637 random numbers that were then matched to the numbered population list.

**Survey Instrument:** A 50 question survey instrument was designed to measure the oral care knowledge, practices and opinions of nurses. The survey started with demographic questions to assess number of years practiced, education, primary area of nursing, principal patient population and amount of patient contact. There were also 2 questions pertaining to whether or not nurses had taken continuing education courses about oral care. Next, there were 9 opinion questions, 12 knowledge questions and 17 questions about oral care practices, with the knowledge questions serving as a test. These knowledge questions, about both basic and specialized oral care, were developed in conjunction with 3 experts – 1 nurse and 2 dental hygienists.

At the beginning of the practice section, a filter question allowed for 2 branches – one for those who did oral assessments and one for those who did not. For the latter group, there was a question regarding why oral assessments were not done and if an oral assessment guide would facilitate assessment. The last 3 questions on the survey were open-ended for providing further information regarding oral care practices and any other information they wanted to add regarding the oral care of their patients.

The survey instrument was pilot tested with 6 nurses who were currently licensed and working at Medical City in Dallas, Texas. All of the nurses worked in bone marrow or stem cell transplant units, areas where patients have special oral care needs. The nurses suggested adding a PhD level of nursing and including more knowledge questions about oral care. These changes were subsequently made to the survey instrument.

**Survey Procedures:** The survey package included the following items: survey, cover letter with investigator signature and stamped return envelope. There were 2 mailings, the initial and the follow up for non-respondents. The informed consent was in the cover letter, and permission was assumed with the return of the survey. The surveys were coded to link them to the identity of the nurses. An assistant tracked the return of the surveys so that the investigator did not know the identity of the respondents. This link was destroyed after data analysis was completed. This project was granted exempt status by the Institutional Review Board of

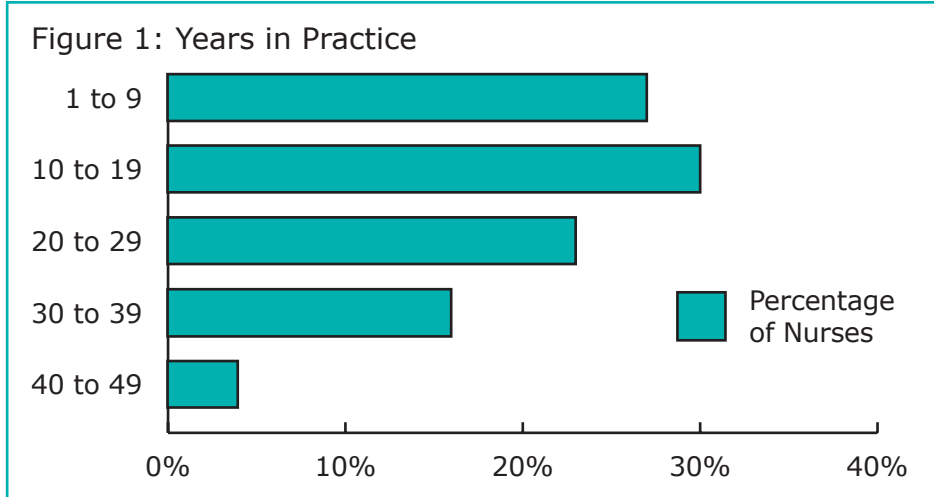


Table I: Level of Education

Education	Count	Percentage
Diploma	10	10%
Associates	32	33%
Bachelors	42	43%
Masters	13	13%
Doctorate	1	1%
Total	98	100%

the Texas A&M Health Science Center Baylor College of Dentistry.

**Data Analysis:** SPSS v.16 was used for statistical analysis. Descriptive statistics were used to identify the oral care knowledge, opinions and practices of the nurses, and Spearman rank order correlation was used to identify the factors that affected these practices.

## Results

A total of 98 surveys were returned for a response rate of 16.8% (98/582). Fifty-five of the 637 nurses had incorrect addresses. Although the response rate was lower than anticipated, this is not unusual in the current environment where surveys are used extensively for collecting information.

**Demographics:** As illustrated in Figure 1, the largest group of respondents had practiced between 10 and 19 years (30%), followed by those who had practiced from 1 to 9 years (27%). As shown in Table I, the largest group of respondents held a bachelors degree in nursing (43%), followed by an associates degree (33%). The largest group of nurses worked in intensive/critical care (39.8%) and had patient contact 10 or more times daily (55.1%)

Only a minority of respondents (n=25) had attended a continuing education course on the oral



Table II: Self-Reported Knowledge, Preparation and Confidence for Oral Care Management

Question	Not at all (1)		Minimal (2)		Enough* (3)		Very much (4)		Total	
	n	%	n	%	n	%	n	%	n	%
How knowledgeable they were about oral care (median=3)	1	1%	31	32%	56	57%	10	10%	98	100%
How well their program prepared them (median=2)	7	7%	44	45%	39	40%	8	8%	98	100%
How confident they felt to provide oral care (median=3)	2	2%	11	12%	53	54%	31	32%	98	100%

\*Actual response categories were "knowledgeable," "prepared" and "confident."

Table III: Responsibility and Importance of Oral Health

Question	Not at all (1)		Minimal (2)		Enough* (3)		Very much (4)		Total	
	n	%	n	%	n	%	n	%	n	%
How important is the oral health of their patients (median=3)	0	0%	5	5%	49	50%	44	45%	98	100%
How responsible they felt for providing oral care (median=3)	6	6%	15	15%	35	36%	42	43%	98	100%

\*Actual response categories were "important" and "responsible."

care management of their patients. Of these, the largest had only attended 1 class (n=13). When asked if they were interested in attending a continuing education course, 41% responded "interested" followed by 32% "minimally interested."

**Opinions:** The survey asked questions regarding nurses' opinions about the oral care management of their patients (Table II). The majority of the nurses reported they were "knowledgeable" (57%), but 32% reported only "minimally knowledgeable." When asked if their nursing program had prepared them for providing oral care, 45% reported only "minimally prepared." Regarding their confidence to provide oral care, 54% reported "confident" and 32% "very confident."

When asked how important the oral health of their patients was to them, 50% responded "important" and 45% "very important" (Table III). Forty-three percent of the respondents felt "very responsible" for providing oral care to their patients and 36% felt "responsible."

Table IV illustrates the specific oral care activities for which they felt responsible. The majority of nurses felt responsible for all the activities except gum health (42%). Most important, 90% felt responsible for cleaning the mouth of their patients.

Table IV: Oral Care Activities for Which Nurses Felt Responsible

Activities	n	%
Cleaning the mouth	88	90%
Alleviating pain in the mouth	74	76%
Denture care	73	75%
Dry mouth	71	72%
Checking the mouth for lesions	69	70%
Checking for missing or loose teeth	54	55%
Gum health	41	42%
No oral care	3	3%

The respondents were asked to rank the top 2 reasons for wanting their patients to maintain healthy mouths. Figure 2 shows their first and second choices. Prevention of infection was most frequent first choice of respondents, but "comfort" was the most frequent for first and second choices combined.

**Knowledge:** Figure 3 illustrates the spread of the scores on the knowledge portion of the survey (12 questions). The majority of the scores ranged from 40 to 60%, with a mean of 50.5% (sd=0.132). Therefore, the respondents performed poorly on the knowledge portion of the survey. Contrary to expectations, there was not a significant correla-



tion between the scores on the knowledge questions and education level of the nurses ( $\rho=0.136$ ,  $p>0.05$ ) or areas in which the nurses worked ( $\rho=-0.080$ ,  $p>0.05$ ).

Table V shows the questions that were answered correctly the majority of the time. Regarding the most common problem created by dental plaque, 89.8% correctly answered "gum disease." The majority of respondents also correctly answered that the toothbrush was the best tool to remove plaque (52%), and the best treatment for candidiasis was antifungal medications (72.4%).

Table VI shows the questions that were answered incorrectly the majority of the time. Ninety-nine percent of the nurses did not know all the conditions that could have the symptom of bad taste. Ninety-seven percent also did not correctly identify all of the medications that can adversely affect the mouth. Particularly disturbing was the fact that only 28.6% knew that dental plaque appears in the mouth after 24 hours in an intubated patient.

**Practices:** The majority of nurses ( $n=77$ , 79%) reported providing oral assessments on their patients. When asked if they were required to perform this on every patient, they reported "yes" according to hospital policy (61.2%) and the nurse manager (50%). Those nurses who performed oral assessments were then asked a series of questions about their practices. Regarding when they looked in a patient's mouth, 49% stated that they did at every assessment, 22% only when patients were first admitted, 21% only when they complained and 11% prior to a major surgery.

Regarding time spent expended for oral care, the largest group spent 5 to 10 minutes per patient (41%), and the second largest group spent less than 5 minutes (38%). When asked how the oral care was documented, 71% stated they recorded it in the patient's chart. However, 8% said they did not document it at all.

The majority of respondents (69%) said they had the supplies they needed for providing oral care. Tables VII and VIII illustrate the equipment they reported using for oral assessments and oral

Figure 2: First and Second Choices for Why Patients Should Maintain Healthy Mouths ( $n=76$ )

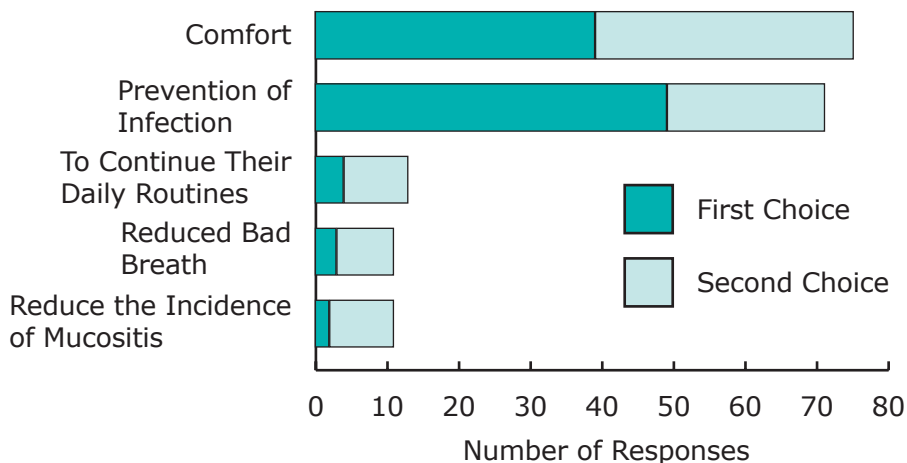
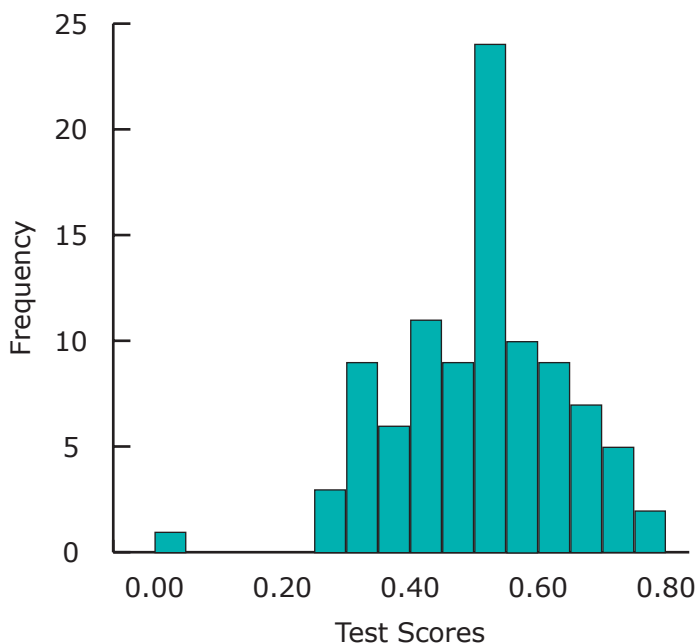


Figure 3: Distribution of Scores on Knowledge Questions ( $n=96$ )



Mean=0.51  
Standard Deviation=0.132

cleanings (plaque removal). The majority of nurses reported using gloves (96%) and tongue depressors (78%) for oral assessments and toothbrushes (82%), gloves (81%) and foam brushes (71%) for oral cleansings. Only 10% reported using some form of oral assessment guide.

The nurses were also asked to identify the most common oral care problems they encountered (Table IX). The most common oral care problems were dry mouth (48%) and missing teeth (36%). Candidiasis (thrush) was not originally on the survey

but was added by 9 respondents.

Regarding the frequency of referrals within the last 6 months (Table X), the largest group of nurses (46%) had not referred a patient to a dentist. The majority of nurses (55%) referred to the patient's personal dentist, while 26% referred to a hospital-employed dentist (Table XI).

For those who did not assess the oral cavity (n=21), the primary reason was it is not a part of hospital protocol to do an oral assessment (n=11), followed by lack of education (n=8), "I am not sure how do an oral assessment" (n=6), not required by nurse manager (n=4), no time (n=3) and not a nursing responsibility (n=3). Seventy percent of these same nurses "disagreed" (50%) or "strongly disagreed" (20%) that an oral assessment guide would result in them doing an assessment.

**Open-ended Questions:** Table XII illustrates the qualitative results of the open-ended questions. For the question of what else they wanted to report about nursing oral health care, the most common theme was oral health is not important. A related theme was the nurses were not required to provide oral care, and the provision of it was not well monitored. In fact, there seemed to be confusion about which hospital professionals were responsible. Respiratory therapists, patient care assistants and nurse technicians were all mentioned as responsible. The second most common theme was they had no time to provide oral care. They were just too busy, and their main priority was preventing VAP. An equally reported theme was nurses did not have enough education for oral care management. The mere act of completing the survey led some respondents to the realization that their oral care knowledge was deficient. The final theme, the unpleasantness of oral care, is well conveyed by the quotations in Table XII.

Regarding the question of what other resources they needed for oral care (Table XII), the most common theme was again more education, including in-service by dental professionals and continuing education. An equally reported theme was the need for more equipment, specifically light sources and dental mirrors. Next was instructions for nurses, including detailed checklists, instructions on how to do an oral assessment and images of what to look for in an oral assessment. All of these would be part of an oral assessment guide.

## Discussion

A cross section of experience was represented in this sample, with a large proportion of both new and experienced nurses. Although minimally

Table V: Frequency of Questions Answered Correctly

Question	% Correct	Correct Answer
Most common problem created by dental plaque? (SQ24)	89.8%	Gum disease
Best treatment for candidiasis (thrush)? (SQ21)	72.4%	Antifungal medications
How often should dentures be cleaned? (SQ25)	65.3%	2 times daily
Best tool for removing plaque? (SQ19)	52.0%	Toothbrush
How often should the appliance be changed in an intubated patient? (SQ27)	50.0%	Every day

trained, they believed they were knowledgeable about oral care management and felt responsible for providing it. Although they reported conducting oral assessments on their patients, almost one half only looked in patients' mouths when they were first admitted or when they complained. Also, their knowledge of current oral care practices was deficient according to the evaluation conducted in this research project. Moreover, they identified barriers to providing oral care in their hospitals.

**Preparation for Oral Care Management:** Over one half of the nurses in this study did not feel their education prepared them for oral care management. Other studies have shown that nurses lack education about oral care and give it a low priority in their work.<sup>5,13-15</sup> The U.S. Oral Health Workforce report by the National Academy of Sciences also stressed the need for modifying the curricula of non-dental professionals to include oral health information.<sup>2</sup> A conclusion that could be drawn here is that the nursing curriculum on oral care management needs to be expanded. Regarding continuing education on oral care, although only one quarter of respondents had attended such a course, three quarters had some interest in attending. This suggests that nurses should be given the opportunity to attend oral care continuing education courses.

**Opinions:** The majority of the nurses believed that oral health was important. They also felt knowledgeable about the oral care management of their patients and responsible for providing it. The latter finding is supported by the study by Binkley et al where nurses also felt responsible for

cleaning their patient's mouth.<sup>19</sup>

**Practices:** The majority of respondents reported providing some oral care to their patients. About three quarters performed oral assessments, and almost one half examined the mouth at every assessment. However, that still left a large proportion of patients who were not receiving oral examinations. Also, it is possible that there was an over-estimation of the amount of oral care provided, as well as self-reported knowledge. There may have been volunteer bias, where nurses most interested in oral health responded to the survey, or non-respondent bias, where those most disinterested, uncomfortable or unaware of its importance did not respond.

Almost two thirds of the nurses reported spending 5 to 10 minutes or more on oral care per patient. The majority reported that their hospital had the supplies they needed, including gloves, tongue depressors, toothbrushes and foam brushes. Since a lack of oral care tools was not cited as a reason for not conducting oral assessments, a shortage of these was not a critical factor in this study.

About two thirds of the nurses were required by their hospital and one half by their nurse managers to conduct oral assessments. The nurses who did not perform oral assessments largely attributed this to hospital protocol not requiring it. This suggests that having a requirement for oral care is necessary for ensuring its provision in hospitals.

Although only a small proportion used oral assessment guides, some nurses believed it would help them provide oral care. It would certainly establish a protocol to follow that would ensure all oral needs are being identified. This is supported

Table VI: Frequency of Questions Answered Incorrectly

Question	% Incorrect	Correct Answer
Bad taste could be a symptom of what? (SQ22)	99%	All choices except high cholesterol
22a. Antibiotics they are taking	(18.4%)	
22b. Kidney stones	(95.9%)	
22c. Poor oral hygiene	(17.3%)	
22d. High cholesterol	(94.9%)	
22e. Lichen planus	(87.8%)	
22f. Anemia	(83.7%)	
22g. Cancer	(57.1%)	
22h. Tooth decay or abscesses	(13.3%)	
What drugs have the potential to adversely affect the mouth? (SQ18)	97%	All choices except birth control pills
18a. Blood Pressure medications	(50.0%)	
18b. Cholesterol medications	(78.6%)	
18c. Birth control medications	(80.6%)	
18d. Seizure control medications	(31.6%)	
18e. Anxiety medications	(48.0%)	
18f. Antidepressant medications	(26.5%)	
How long before bacterial plaque appears in an intubated patient's mouth? (SQ26)	71.2%	24 hours
Best option for non-restorable teeth? (SQ20)	59.1%	Extraction of non-restorable teeth immediately
Current recommended dose of Chlorhexidine to be given daily? (SQ23)	57.1%	30 ml/day
At what point can immune suppressed patients have their teeth cleaned? (SQ16)	51.8%	6 months

Table VII: Equipment Used for Oral Assessments

Equipment	Count	Percentage*
Gloves	74	96%
Tongue depressor	60	78%
2x2 gauze	26	34%
Penlight	12	16%
Mirror	10	13%

\*Percentages reflect those who do oral assessments, 77/98 total respondents.

by the Kinley et al study where they found that implementing standard protocols and tools increased the quality and frequency of oral care.<sup>28</sup>

Almost one half of the nurses had never referred a patient to a dentist in the last 6 months. Since hospitalized patients may have associated oral problems or susceptibility, they need continu-

Table VIII: Equipment Used for Oral Cleanings

Equipment	Count	Percentage*
Toothbrush	63	82%
Gloves	62	81%
Foam brush	54	71%
Chlorhexidine	34	44%
2x2 gauze	24	31%
Mirror	15	19%
I do not do oral cleansings	10	13%
Fluoride Rinse	8	10%

\*Percentages reflect those who do oral assessments, 77 of 98 total respondents.

Table X: Frequency of Dental Referrals in the Last Six Months

Frequency	Count	Percentage
Never	35	46%
1–2 times	28	37%
3–5 times	8	11%
6–8 times	1	1%
More than 8 times	4	5%
Total	76	100%

ing oral care once they leave. For example, an oncology patient who has received radiation therapy needs ongoing assessment for the signs and symptoms of osteoradionecrosis. Also, follow up is needed for the control of periodontal disease, because it is so closely associated with systemic health.

**Knowledge:** The majority of respondents performed poorly on the test portion of the survey. The questions missed most often concerned the effects on medications on the oral cavity and appropriate management of special oral problems. For example, nurses should know that certain drugs adversely affect the oral cavity. The fact that nurses did not feel responsible for the gum health of their patients illustrates their lack of knowledge about the oral and systemic health connection. This suggests that their care of patients could be improved with more current information about these topics, either in their nursing education or in continuing education.

One could hypothesize that certain areas of nursing would encounter oral problems more frequently than others, such as oncology and ICUs, and would have a greater knowledge of oral care.

Table IX: Most Common Oral Care Problems Reported

Problems	Count	Percentage*
Dry mouth	37	48%
Missing Teeth	28	36%
Caries	22	29%
Mucositis	20	26%
Mouth Lesions	19	25%
Loose Teeth	17	22%
Candidiasis (Thrush)	9	12%

\*Percentages reflect those who do oral assessments, 77/98 total respondents.

Table XI: Referral Sources

Referral Sources	Count	Percentages
Patient's personal dentist	23	55%
Hospital employed dentist	11	26%
Dentist in the community	5	12%
Did not refer them to a dentist	3	7%
Total	42	100%

This could also apply to years of education. However, neither of these influenced the nurses' performance on the knowledge portion of the survey. These findings further highlight the lack of oral care education and knowledge of nurses and stress the need for change.

**Reasons for Lack of Oral Care:** The responses of the nurses revealed a disconnect between feeling responsible yet somewhat unable or ill-prepared to provide adequate oral care for their patients. They said they did not have enough time for oral care on top of all the other tasks they had to perform. They were focused on saving lives, and thus oral care had a very low priority. They also did not know how to administer oral care, and many were not required to provide it. Some were even unsure whether oral care was their responsibility or that of another health care provider in the hospital, such as the respiratory therapists or the certified nursing assistants.

**Collaboration/Inter-professional Practice:** This study suggests that nurses need further resources for oral care management. Minimally, in-service courses could be developed that are taught by dental specialists. Miller and Rubenstein

Table XII: Qualitative Themes & Responses to Open Ended Questions

Themes	Responses	n*
Question 49. Is there anything else you would like us to know about nursing oral health care?		33
Oral health is not important and overlooked	<ul style="list-style-type: none"> <li>• "I know that proper oral hygiene is important for maintaining patient's health, but in reality I see it is not given as high a priority as it deserves as a tool to compete (fight) the illness."</li> <li>• "There needs to be more of it, and it is usually omitted from routine patient care."</li> </ul>	8
No time to provide oral care	<ul style="list-style-type: none"> <li>• "My main priority was preventing VAP (ventilator acquired pneumonia)."</li> <li>• "All the nurses are busy and it is easier to skip it."</li> <li>• "There is not enough time. In our hospital the RT's (respiratory therapists) are responsible for it."</li> </ul>	5
Not enough education for oral care management	<ul style="list-style-type: none"> <li>• "Oral care seems to take a back seat to other disease processes and needs to be stressed more in our schools and to our patients—I will take a CE (continuing education) course after taking your survey. I see I am severely lacking in my knowledge base."</li> <li>• I "recently read a nursing journal article on oral hygiene and it shocked me—I think this kind of information should be available to all nurses, patient care techs, and doctors as mandatory education."</li> <li>• "I unfortunately have very poor knowledge in this area, and I am embarrassed."</li> <li>• "I feel this is an area that is not assessed or taught to nurses properly."</li> </ul>	5
Not part of nursing protocol and "loosely monitored"	<ul style="list-style-type: none"> <li>• "... nurses and techs do not feel that oral care is that important, and supervisors do not follow up and so it is not done."</li> <li>• "Other people such as RT's (respiratory therapists) are responsible for oral health care of patients."</li> <li>• "It seems that oral mouth assessments and care could be provided by patient care assistants in accordance with set policy protocols."</li> </ul>	3
Oral care is unpleasant	<ul style="list-style-type: none"> <li>• "Unresponsive, mouth breathers have dry thick chunks that stick on their tongue or roof of the mouth. Many nurses and techs won't touch it. They need teaching on oral care, cleaning, and suction."</li> <li>• "Most nursing staff I know are completely disgusted with oral care. 'Let the CNAs (certified nursing assistants) take care of it.' I don't mind the oral care, since I was a dental assistant for two years."</li> </ul>	3
Question 50. What else might you need to do an oral assessment, oral cleansing/plaque removal and oral hygiene instructions at your hospital?		51
More education	<ul style="list-style-type: none"> <li>• "I had a patient that was recently transferred to our unit from ICU (Intensive Care Unit) with respiratory and swallowing problems and found hard buildup of food and drainage at the back of her tongue—no one from ICU had assessed this for over a week. Obviously, nursing in all areas is in need of education in oral assessments as well as physicians."</li> <li>• In-service on oral health care done by a dentist or dental hygienist</li> <li>• Continuing education</li> </ul>	10
More Equipment	<ul style="list-style-type: none"> <li>• Light sources and dental mirrors</li> </ul>	10
Instructions for nurses	<ul style="list-style-type: none"> <li>• Detailed checklists</li> <li>• Instructions on how to do an oral assessment</li> <li>• Images of what to look for</li> <li>• Oral assessment guide</li> </ul>	9
Instructions for patients	<ul style="list-style-type: none"> <li>• "Pointed instructions so that patients can read and learn self care"</li> </ul>	3

\*The N values for the individual themes do not add up to the overall N values, because there were additional unrelated responses that were not included here.

recommended that nurses use dental publications for their education and hire dentists and dental hygienists as lecturers and consultants.<sup>5</sup> Continuing education on oral care could also be devel-

oped and even required for licensure. If dental hygienists were employed in hospitals, nurses could collaborate with them on the oral care treatment plans for patients. Dental hygienists could even



manage the oral care of hospitalized patients, freeing up the nurses to focus on all the other critical interventions that are needed. This inter-professional practice at the hospital would provide optimal care for the patients and relieve the stress of the nurses. The Surgeon General's report on oral health stressed the need for health care providers to collaborate with dental professionals in providing optimal oral health for patients. This would necessitate curriculum changes to their educational programs and multidisciplinary training.<sup>1</sup> At least 2 Institute of Medicine reports have identified inter-professional care as the future vision for patient-centric, evidence-based health care, for all health professions and specifically for nursing.<sup>31,32</sup>

## Conclusion

The increasing awareness of the significant relationship between oral and systemic health highlights the importance of oral care management in hospitals. This is further amplified by the growing body of evidence that improved oral status can improve health outcomes in hospital settings – the lowering of morbidity and mortality. Making oral care management a higher priority might significantly improve the health of hospitalized patients. The following recommendations were suggested by this research project:

- Increase the amount of oral care management education that nurses receive in their nursing programs. This study could help nurse educators evaluate their curriculum and include more oral health education.
- Develop hospital policy and protocols that mandate daily oral assessments and oral care for all patients. In this study, oral care was not performed, because it was not hospital protocol or

required. Policy and protocols would include the tools needed for oral care and oral assessment guides to standardize the examination process.

- Provide oral care education for nurses at their hospitals through in-service and guest speakers. Lack of education and not knowing how to provide oral care was another reason for not conducting oral care. In-service education by dental professionals could improve their oral care skills.
- Require all nurses to take at least 1 continuing education class a year about oral care. Requiring continuing education courses would ensure that nurses received the most current information about oral care management.
- Hire dental hygienists and dentists to do the oral care management of patients in hospitals, because it is their specialized field. They could work with nurses and other hospital personnel in the inter-professional treatment of patients to ensure the best possible care and health outcomes.

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## Assessment and Maintenance of Dental Implants: Clinical and Knowledge-Seeking Practices of Dental Hygienists

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### Introduction

Dental implants have become the treatment of choice for replacing missing teeth, and the frequency of placement has rapidly increased since the mid-1960s.<sup>1</sup> Varying results have been reported in studies related to assessing dental implants, identifying signs of failure, planning continued care, implementing treatment and evaluating outcomes.<sup>2-5</sup> Researchers have expounded on various protocols for the assessment of dental implants, which include obtaining radiographs and assessing periodontal health (probing depths, mobility, bleeding on probing and inflammation).<sup>6,7</sup> After systematic reviews of randomized controlled trials, Faggion et al developed an evidence-based algorithm for the treatment of peri-implantitis.<sup>4</sup>

It is widely known that bleeding on probing is an indicator of inflammation of soft tissue whether around natural teeth or implants. However, there is controversy regarding the frequency of probing around dental implants due to risk of damaging delicate peri-implant tissues.<sup>5</sup> Another concern is introducing bacteria into peri-implant tissues from surrounding teeth for which Terraciano suggests avoiding cross contamination by probing and scaling dental implants first.<sup>2</sup> Overall, researchers agree that gentle probing is an important part of the implant recall.<sup>2,5,7,8</sup>

### Abstract

**Purpose:** This study surveyed dental hygienists in order to assess their routine approach for dental implant maintenance and to determine if a relationship exists between the formal education of dental hygienists and their previous attendance and interest in future implant related continuing education courses.

**Methods** A survey was distributed to dental hygienists attending an annual national continuing education course. Participants voluntarily completed and submitted their survey before the end of the first day of the 3 day course.

**Results:** The results indicate that there is a statistically significant relationship between the level of formal education and implant related continuing education course attendance. Dental hygienists whose formal education did not include dental implant care were more likely to attend implant related continuing education courses than those whose formal education included this content. The majority of the dental hygienists expressed interest in continuing education courses on dental implants. Results of chi-square analysis show a statistically significant relationship between the type of education and interest in attending implant related continuing education courses. There was no statistically significant difference in continuing education interest between dental hygienists whose formal education did or did not include dental implants.

**Conclusion:** Additional continuing education courses have been completed by most dental hygienists whose curricula did not include formal training on dental implant care. Most dental hygienists are interested in gaining additional knowledge whether or not their dental hygiene curriculum contained content on dental implants.

**Keywords:** Dental implants, dental hygienists, oral examination, instrumentation, dental continuing education

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

The use of plastic probes is recommended to produce less damage to the implant surface and to provide more flexibility when positioning it parallel to the long axis of the abutment.<sup>2,9</sup> For the most

gentle probing around dental implants, a plastic controlled-force probe is recommended.<sup>10</sup>

Heitz-Mayfield described best practices for detecting implant failure using mobility tests and radiographic findings.<sup>11</sup> Radiographs are deemed an integral component of implant maintenance and the most important assessment tool for evaluating implant status.<sup>6,12</sup> The literature varies as to the recommended interval for taking radiographs. Recommended maintenance protocols distinguish necessary care during and after the first year of implant placement. A few of the various protocols suggested are:

- Initial placement: 6 months, 12 months and every 2 years<sup>12,13</sup>
- Initial placement: 1, 3 and 5 years if no pathology present<sup>5</sup>
- Initial placement: 6 and 12 months, annually if no pathology present – if pathology present, every 6 months until resolution<sup>14</sup>

Panoramic radiographs are most valuable when determining potential implant candidates.<sup>2</sup> Radiographs can be used to determine bone loss over time, to identify areas of radiolucency that could indicate implant failure, and to confirm adequate seating of the abutment or prosthesis.<sup>2,5,8,9,11,12</sup> Periapical radiographs using the paralleling technique have been recommended to assess bone loss and implant components.<sup>5</sup> When evaluating dental implants after placement, panoramic radiographs are considered helpful tools by some while others question their value.<sup>5,13</sup>

The dental hygiene appointment may include debridement of hard and soft deposits using hand and power instruments designed specifically to protect the delicate implant surface. Recare intervals of 3, 4 or 6 months are recommended for careful evaluation of peri-implant tissues by the dental hygienist and dentist.<sup>8</sup>

Persson pointed out that it is likely that the instruments available for debridement around implants are not properly designed to reach affected areas.<sup>3</sup> This limitation is mentioned because implant design, location and clinical conditions make it difficult to provide adequate debridement of dental implants. While searching for ideal implant tools, researchers have studied the effect of several debridement instruments on implant surfaces. Summaries of their findings include:

- Titanium hand instruments versus ultrasonic scalers: no group differences were found in the treatment outcomes. Plaque and bleeding

scores improved in both groups, with no effects on probing depths<sup>15</sup>

- Resin tipped scalers versus gold coated or graphite instruments: resin tipped scalers do not create scratches and performed better than gold coated/graphite instruments<sup>16</sup>
- Plastic scalers versus ultrasonic device: plastic scalers produced less alteration of titanium surfaces than ultrasonic device<sup>17</sup>
- Curettes versus ultrasonic device: no group differences in the ability to reduce the microbiota in peri-implantitis<sup>3</sup>
- Ultrasonic scalers covered with a plastic sheath and Ultrasonic scalers with carbon tips versus metal scalers: carbon and plastic tipped ultrasonics produced smooth implant surfaces while metal tips resulted in damaged implant surfaces<sup>18</sup>

Dental hygienists are routinely responsible for the continuity of patient education and maintenance of dental implants, years beyond initial placement. This care is referred to as the “first line” therapy or the nonsurgical approach.<sup>4</sup> However, there is a paucity of evidence based research regarding the best practices for implant maintenance, specifically by the dental hygienist. Graduates prior to the late 1990s may have had little to no formal education on implant care, yet they are treating patients with dental implants. Dentists are encouraged to actively seek standardized and comprehensive training via professional-centered education.<sup>4</sup> Professional continuing education may similarly fulfill this need for dental hygienists.

In this current study, authors surveyed dental hygienists from diverse educational and practice backgrounds in order to assess their routine approach for dental implant maintenance. This study also sought to determine if a relationship exists between the formal education of dental hygienists and their previous attendance and interest in future continuing education courses about implants.

## Methods and Materials

After an extensive review of the literature, faculty at the Medical College of Georgia Department of Dental Hygiene developed a 24-item paper survey specifically for this study. All items on the survey reflected content found in publications that addressed maintenance of dental implants. Only the faculty considered the questions and content validity of the survey. The protocol for this study was submitted to the institution’s Human Assurance Committee. Upon review of the proposal, it was determined that this study was not considered human subjects research as defined by the federal regulations because the data obtained was restrict-



ed to assessing the practices of dental hygienists.

Upon arrival to an annual national continuing education course, the instrument Dental Hygiene Care of Implants–Survey of Dental Hygienists was distributed to all attendees (n=370). All course attendees were female and the states they represented are shown in Table I. Participants were conveniently sampled and volunteered to submit their survey before the end of the first day of the 3 day course. Surveys submitted after the first day of the symposium were not included in this study because lectures on implant maintenance were scheduled for the second day. Completed surveys were returned to the continuing education staff members before the data collection deadline. Data were entered in a spreadsheet by 1 author and then independently verified by another author to ensure accuracy.

## Results

Survey response rate was 57.5% (n=213). Most dental hygienists (n=170, 80%) reported employment in a general practice setting, followed by 7% (n=14) in periodontal practice. The remaining 13% (n=27) reported working in other settings which included pediatric, endodontic and government entities. One hundred and five (49%) reported that they have practiced for over 15 years, while 38 (18%) have practiced 11 to 15 years and 66 (31%) have practiced 10 years or less.

Table II details dental implant training, history of continuing education and interest of the participants in future continuing education courses on dental implants. Half of the participants reported that they received formal training on dental implants during their dental hygiene education and about half reported that they did not receive such training. A chi-square test was used to determine if there is a relationship between the type of education (formal education versus no formal education) and continuing education course attendance (attended course versus did not attend course). The results indicate that there is a statistically significant relationship between the type of education and continuing education course attendance (chi-square with 1 degree of freedom=5.435, p=0.019). Dental hygienists whose formal education did not include dental implant care were more likely to attend continuing education courses than those whose formal education included this content. There was no statistically significant difference in continuing education interest between dental hygienists whose formal education did or did not include dental implants (chi-square with 1 degree of freedom=0.021,

Table I: States Where Participants Practice Dental Hygiene

State	Number	%
GA	277	75
SC	43	12
NC	19	5.1
FL	17	4.6
VA	2	0.5
KY	2	0.5
MD	1	0.3
NJ	1	0.3
TN	6	1.6
OH	1	0.3
IL	1	0.3
Total	370	100

Table II: Dental Implant Training and Continuing Education

	n	%
Received training in classroom and clinic on implant care while attending dental hygiene school	25	12
Did not receive any training on implant care while attending dental hygiene school	108	51
Attended one or more continuing education courses on implant maintenance	111	52
Has not attended continuing education courses on implant maintenance	100	47
Interested in a continuing education course to strengthen background in maintenance of dental implants	198	93
Not interested in a continuing education course to strengthen background in maintenance of dental implants	12	5.6

p=0.88). Most dental hygienists (n=199, 93.9%) expressed interest in continuing education courses on dental implants.

A summary of the survey responses regarding procedures for dental implant maintenance is shown in Tables III through VII. Table III summarizes responses regarding the clinical assessment of dental implants. Over 90% (n=193 to 198) of participants reported that they evaluate plaque/calculus deposits, exudate/bleeding, mobility and inflammation. Fewer (n=67, 31%) evaluate the presence of salivary percolation around the margin of crowns covering implants. The major-

Table III: Clinical Assessment of Dental Implants

	n	%
Evaluates amount of adjacent keratinized tissue	104	49
Evaluates color of adjacent gingival tissue (inflammation present)	193	91
Evaluates presence of stippling/tissue consistency	133	62
Evaluates presence of exudate/bleeding	196	92
Evaluates presence of deposits (plaque and/or calculus)	198	93
Evaluates presence of salivary percolation when slight pressure is applied to the crown of an implant	67	31
Evaluates mobility	195	92
Evaluates occlusion	113	53
Evaluates parafunctional habits (grinding, abrasion)	121	57
Evaluates recession	173	81
Probes around implants	162	76
Does not probe around implants	39	18
Uses plastic probe	149	70
Uses metal probe	17	8
Uses pressure-sensitive plastic probe	9	4.2
Uses automated probe	0	0
Records the presence of bleeding on probing around the implant	153	72
Does not record the presence of bleeding on probing around the implant	14	6.6
Establishes a fixed reference point such as the margin of a crown to use during probing	98	46
Does not establish a fixed reference point such as the margin of a crown to use during probing	65	31

Table IV: Radiographic Assessment of Dental Implants

	n	%
Takes radiographs of an implant once a year	117	55
Takes radiographs of an implant every 6 months	28	13
Takes radiographs of an implant every 3 months during the 1st year and every 6 months thereafter	12	5.6
Takes radiographs of an implant every 3 months during the 1st year and annually thereafter	20	9.4
Takes radiographs of an implant at a different established interval	9	4.2
Takes radiographs of an implant at no set interval	32	15
Uses other intervals for scheduling implant patients for maintenance after the first year of completion	12	5.6
Routinely takes periapical radiographs of implants	147	69
Routinely takes vertical bitewing radiographs of implants	48	23
Routinely takes horizontal bitewing radiographs of implants	50	23
Routinely takes panoramic radiographs of implants	31	15
Does not routinely take radiographs of implants	12	5.6
Checks bone level surrounding the implant on a regular basis at maintenance appointments	178	84
Does not check bone level surrounding the implant on a regular basis at maintenance appointments	27	13

ity of respondents probe around dental implants (n=162, 76%) and use a plastic probe (n=149, 70%). In Table IV, over half (n=117, 55%) take radiographs of dental implants at least once per year, and 69% (n=147) reported periapicals as the most common type of radiograph taken.

In Table V, dental hygienists most commonly reported that they perform both supragingival and subgingival instrumentation around dental implants (n=164, 77%). Most (n=190, 89%) use plastic scalers during debridement, while a few (n=16, 7.5%) use stainless steel scalers on dental implants. As shown in Table VI, most dental

hygienists (n=151, 71%) do not dip the probe in an antimicrobial agent prior to using it to evaluate dental implants. Almost half (n=97, 45.5%) administered a microbial rinse and half do not (n=107, 50%).

Maintenance intervals for patients with dental implants are reported in Table VII. Most respondents (n=166, 77%) indicated that they schedule patients every 3, 4 or 6 months during the first year after completion of the dental implant. Forty percent (n=86) reported that, after the first year of placement, maintenance intervals are primarily based on individual need.

## Discussion

The date of graduation from their dental hygiene program may explain why over half of the participants in this study did not receive formal training on dental implant maintenance. Dental implants may not have been part of their curriculum. Humphrey notes that dental implants have now become an integral part of dental reconstruction and quotes that approximately 300,000 to 428,000 dental implants are placed annually in the U.S.<sup>5</sup> Accordingly, it is imperative that dental hygienists have the most current knowledge for the maintenance of dental implants.

The majority of participants surveyed in this study follow the recommendations of Kurtzman during visual inspection of tissues surrounding dental implants, noting color, texture, amount of biofilm and calculus, probing depths, bleeding, mobility and recession.<sup>8</sup> Most reported they probe dental implants. Although probing causes a separation between the surface of the implant and the junctional epithelium, it is still deemed an indispensable part of implant maintenance.<sup>7</sup>

About 5% (n=11) reported they dip the probe in an antimicrobial rinse prior to use on dental implants to avoid cross-contamination. However, there has not been any substantial evidence to validate the effectiveness of this approach. Fifty percent (n=107) reported use of an antimicrobial rinse as part of their implant care protocol, although current evidence does not show a significant difference between debridement alone and debridement with antimicrobials.<sup>19,20</sup> The frequency of taking radiographs varied amongst participants in this study, which is consistent with the variety of protocols suggested in the literature.<sup>5,12-14</sup>

Table V: Implementation of Dental Hygiene Care Plan

	n	%
Has an established protocol in office for home care instructions for implant patients	130	61
Does not have an established protocol in office for home care instructions for implant patients	75	35
Performs supragingival instrumentation around implants	39	18
Performs subgingival instrumentation around implants	7	3.3
Performs both supragingival and subgingival instrumentation around implants	164	77
Uses stainless steel scalers during debridement around implants	16	7.5
Uses plastic scalers during debridement around implants	190	89
Uses graphite scalers during debridement around implants	26	12
Uses teflon coated scalers during debridement around implants	22	10
Uses gold-tipped scalers during debridement around implants	8	3.8
Uses ultrasonic scalers with standard inserts during debridement around implants	13	6.1
Uses ultrasonic scalers with specific implants during debridement around implants	25	12
Uses other type of instruments during debridement around implants	10	4.7
Uses fine prophy paste for polishing the implant/crown	80	38
Uses medium prophy paste for polishing the implant/crown	44	21
Uses tin oxide for polishing the implant/crown	7	3.3
Uses air polisher for polishing the implant/crown	40	19
Uses toothpaste for polishing the implant/crown	25	12
Uses prophy paste designed for implants for polishing the implant/crown	17	8
Uses other agents for polishing the implant/crown	16	7.5
Polishes the implant post if it is visible	91	43
Does not polish the implant post if it is visible	105	49

In this study, most dental hygienists used plastic scalers as recommended in the literature.<sup>2,9,10</sup> However, a few participants reported that they use metal scalers and ultrasonic scalers with standard inserts. Periodic evaluation of the dental implant is critical to the health of peri-implant tissues. Participants in this study indicated they follow the traditional 3 to 6 month re-care interval. This finding correlates with the recommended 3 month re-care intervals during the first year after implant placement and continuous supervision of the patient with implants.<sup>5,9</sup> There is a paucity of refereed evidence based research that specifically addresses the care of implants by the dental hygienist. Accordingly, Hultin suggests that there is a need for such studies to be initiated.<sup>21</sup>

Results of this study cannot be generalized to

the entire population of dental hygienists due to the limitations of using a convenience sample. Further studies should include a sample that is representative of the 130,000 active dental hygienists in the U.S.<sup>22</sup> The popularity of dental implants will continue to increase with the aging population who will demand more esthetic care. Thus, dental hygienists will continue to be the first line of therapy in maintaining healthy peri-implant tissues.

## Conclusion

This study provided a descriptive summary of knowledge-seeking practices and clinical approaches used by dental hygienists in the maintenance of dental implants. Over half of the participants in this study did not have formal training on dental implants during their dental hygiene education, but have taken continuing education courses. Regardless of whether they had formal training or not, most dental hygienists are interested in gaining additional knowledge regarding dental implants.

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Table VI: Use of Antimicrobials

	n	%
Dips the probe in an antimicrobial rinse prior to use on implants	11	5.2
Does not dip the probe in an antimicrobial rinse prior to use on implants	151	71
Uses an antimicrobial rinse as part of implant care protocol	97	45.5
Does not use an antimicrobial rinse as part of implant care protocol	107	50
Uses chlorhexidine antimicrobial rinse as part of implant care protocol	83	39
Uses essential oils antimicrobial rinse as part of implant care protocol	43	20
Uses cetylpyridinium chloride antimicrobial rinse as part of implant care protocol	15	7
Uses other antimicrobial rinse as part of implant care protocol	7	3
Uses antimicrobial as pre-rinse	60	28
Uses antimicrobial as oral irrigation	49	23
Uses antimicrobial as a dip for floss/gauze	11	5
Uses antimicrobial as a dip for the probe	8	4

Table VII: Maintenance Intervals

	n	%
Schedules implant patients for maintenance once during the first year after placement	1	0.5
Schedules implant patients for maintenance every 3 months during the first year after placement	73	34
Schedules implant patients for maintenance once every 4 months during the first year after placement	22	10
Schedules implant patients for maintenance once every 6 months during the first year after placement	71	33
No established policy for scheduling implant patients for maintenance during the first year	37	17
Uses other intervals for scheduling implant patients for maintenance during the first year	14	6.6
Schedules implant patients annually for maintenance after the first year of completion	6	2.8
Schedules implant patients every 3 months for maintenance after the first year of completion	31	15
Schedules implant patients every 6 months for maintenance after the first year of completion	80	38
Schedules implant patients based on individual need for maintenance after the first year of completion	86	40

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## Perception of Oral Status as a Barrier to Oral Care for People with Spinal Cord Injuries

Amy L. Sullivan, RDH, PhD

### Introduction

According to the American Association of People with Disabilities, 19% of the American population (49 million) have a disability.<sup>1</sup> Of this population, approximately 255,702 sustained a spinal cord injury (SCI), with approximately 10,000 to 12,000 new SCIs per year.<sup>2,3</sup> According to the Mississippi Department of Health Spinal Cord and Traumatic Injury Registry, approximately 1,500 people with a SCI are living in Mississippi.<sup>4</sup> This incidence rate in Mississippi, calculated without including pre-hospital mortalities, is more than twice the national average.<sup>5</sup> Primary risk factors for new SCIs are largely attributed to Mississippi's high rate of motor vehicle crashes, low safety belt usage, poor road conditions, violence in high crime neighborhoods and falls.<sup>5-7</sup>

While the Surgeon General's report addresses the relationship between overall health and oral health,<sup>8</sup> very little research has been conducted on oral health among people with SCIs. The literature review provides an insight to the SCI individual's access to dental care dilemmas and perception of own oral health. The results may serve as a foundation for developing programs and policies to improve oral care for people with SCIs, such as special training, clinics that specifically address SCI oral needs, better usage of dental hygienists, provision of transportation, education and governmental economic support for oral health care among people with SCIs.

The hypothesis of this study states that people with SCIs perceive their oral health status as better than the dental experts' examination scores. More people with SCIs will think they

### Abstract

**Purpose:** The purpose of this study was to examine the oral health status of people with spinal cord injuries (SCIs) and determine if people with a SCI have an accurate perception of their oral status, and if this is potentially a barrier to oral care. Methods consisted of a survey and oral examination given to 92 willing participants of the Methodist Rehabilitation Center who sustained a SCI. The examination consisted of periodontal status using Periodontal Screen and Recording Index™ and dental status using Decayed, Missing, Filled Teeth index. Oral health score was also determined through questioning the participant. These scores, retrieved by the dental hygienist, were then compared to what the SCI individual's perception of their own oral health. Results indicate their perception of oral health was much better than dental assessment showed. Additionally, more than 18% of this population was completely unaware of decay which was found in over half of those studied, and more than 60% were unaware of periodontal disease that was exhibited in over 75% of those studied. This comparison evaluated a major awareness about the need for education and oral care among the SCI population.

**Keywords:** dental hygienists, spinal cord injuries, barriers to oral care

This study supports the NDHRA priority area, **Health Services Research:** Assess the impact of increasing access to dental hygiene services on the oral health outcomes of underserved populations.

have a healthy mouth ("Do you think your mouth is healthy?") compared to the actual Oral Health Score (OHS). Fewer people with SCIs will think they have cavities ("Do you think you have cavities?") compared to the actual Decayed, Missing, Filled Teeth (DMFT) score. Finally, fewer people with SCIs will think they have gingivitis ("Do you think you have gum disease?") compared to the actual Periodontal Screen and Recording Index™ (PSR).

SCIs can cause loss of movement (paralysis) and feeling below the site of the injury. Paralysis that involves the majority of the body, including the arms and legs, is called quadriplegia or tetraplegia. When SCIs affect only the lower body, the

condition is called paraplegia. In general, people with SCIs are more prone to develop diabetes, hypertension, obesity, bladder infections, depression and wounds, such as pressure ulcers.<sup>9</sup> Individuals with SCIs must also learn to control or respond to autonomic dysreflexia, psychosocial and quality of life issues. Their general needs include management of urinary tract, gastrointestinal tract, integumentary system (pressure sores), cardiovascular system and neurological system. Issues pertaining to these systems are taught and reinforced during rehabilitation.<sup>10</sup> More specifically, SCI patients with an injury lower than the seventh cervical vertebra (C7) should ideally be able to independently accomplish all activities of daily living with the exception of walking. In individuals with a C7 and higher SCI, the focus turns towards meeting primary goals such as self-care and bladder and bowel care.<sup>11</sup> Hence, the SCI population often has difficulty participating in activities of daily living. Foremost among these restrictions is the access of health care services.<sup>12</sup>

People with SCI often face greater barriers to care than those in the able population. In general, barriers that may limit maintenance of proper oral health include a lack of dental professionals on the rehabilitation team, fear, lack of transportation, lack of accessibility to the dental office and lack of financial assistance. Overcoming these potential barriers to oral health care among the SCI population requires a better understanding of their oral care, practices and perception of their dental status.

Dental professionals are typically not members of a rehabilitation team and dental clinics are not a part of rehabilitation centers.<sup>13</sup> It is a dental professional who will more likely recognize gingival conditions and/or dental decay compared to all other caregivers.<sup>14</sup> Dental care should be coordinated with other health care professionals.<sup>15</sup> Dental care is less complex while the disabled is still in a rehabilitation facility that includes an on-site dentist rather than waiting until the patient is home relying on a caregiver, although most caregivers are the ones who are instrumental in taking the disabled to the dentist.<sup>16</sup> Modifications to routine procedures may also be indicated, such as proper airway position and wheelchair transfers. This coordination would be more easily accessible in rehabilitation centers which can include the appropriate professionals all in one setting.<sup>17</sup>

Persons with disabilities report a high level of fear, anxiety and nervousness towards dental visits.<sup>18,19</sup> Although it may be thought that this is true among the entire population and not just

those with a disability, only 20% of the overall population reported being nervous versus 34% of the special needs population.<sup>19</sup> Perhaps this is due to the lack of regular dental care that has not been easy to access, or perhaps it is due to an unpleasant past dental experience. The point is that many more dental appointments would be kept if sedation were offered to those who were anxious.<sup>20</sup>

Within the environment of the dental office are several factors which contribute to the barriers of dental care. Scheduling and keeping appointments, enduring wait times, dealing with dental staff, feeling rushed, gaining access, filing insurance and coping with the actual dental chair or cubicle space are among some of these office barriers. Excessive wait times, while an inconvenience to most, create special problems for SCI clients. The reports of excessive wait times were generally dealing with Medicaid patients as opposed to those paying with cash.<sup>21</sup> This can be a serious problem for the fact that most SCI patients have bladder, bowel and pressure ulcer issues and they will need to be treated in a timely manner. Also, if wait times are minimal, this leaves less time for the client to be nervous. Some patients perceived the office personnel as being rude, disrespectful, judgmental and insensitive to their disability or the fact that they had Medicaid.<sup>21</sup> Others report after waiting for long periods of time that the dentist was rushed and did not spend adequate time treating them. These experiences create strong barriers for some and discourage dental care in general.<sup>21,22</sup> Although transportation is provided through social services for those who do not own or cannot drive a car, this service was considered unreliable and inconvenient. The 2 barriers of transportation and scheduling appointments, when combined, make the possibility for being late or not making the appointment at all a strong likelihood.<sup>21</sup>

Dental offices must follow the guidelines provided by the Americans with Disabilities Act. Dentists are required to make reasonable modifications to facilitate access into the dental office by providing wheelchair ramps, spacious washrooms with grab bars at the correct level, raised toilets, widened paths and doorways and parking.<sup>23,24</sup> Dental professionals can also learn certain techniques to help transfer the SCI patient into the dental chair.<sup>25,26</sup> Dental offices must become more accessible to the physically challenged.<sup>27</sup>

Underutilized dental services are not surprising, due to the fact that many people who sustain SCIs are deprived socioeconomically. Most den-

tal care that is provided is paid by the SCI individual's personal insurance. Since personal insurance is often provided through work, many of these individuals simply do not have insurance. However, even SCI individuals fortunate enough to have their own private insurance reported difficulty with the insurance filings.<sup>19</sup> Although having insurance was not a significant variable in receiving rehabilitation services,<sup>28</sup> payors and the lack of finances are a very important reason why those with SCIs may have difficulty accessing dental care. People with SCIs reported the greatest occurrence of difficulty accessing needed services, with the most frequently cited reason for this difficulty was the provider did not take Medicaid.<sup>12</sup> Those that have SCIs are eligible for Medicaid, but it is difficult to find a dentist willing to take this form of payment.<sup>21</sup> In addition, there are certain criteria used to determine when or if SCI individuals are eligible for this federal assistance.

Until recently, literature was not available specifically on the oral health of those with SCIs. The general foundation for the above literature review which spawned this study was supported by extrapolating data from studies pertaining to those with special needs and making the link to those with SCIs. Since this study's completion, a few new studies specifically related to oral health of those with SCIs have been released. These studies also support the above literature review stating that half the people with SCIs report current oral problems, have barriers to oral care, are less likely to have had dental cleanings than the general population and potentially have more dental caries.<sup>29-31</sup>

Table I: Descriptive Statistics of SCI Subjects (n=92)

Age	Range: 18–71 Mean: 41
Age of SCI occurrence	Range: 15 to 69 Mean: 33
Race	Caucasian: 55% African American: 45%
Gender	Male: 72% Female: 28%
County	Rural: 46% Urban: 54%
Income	Don't know: 25% \$14,000 or less: 35% \$15,000 to \$34,999: 16% \$35,000 to \$64,999: 17% \$65,000 and above: 7%
Education	Not completed high school: 30% High school graduate: 57% College/ technical graduate: 13%
Living situation	Institutionalized: 17% Live in partner/spouse: 65% Self/alone: 17%
Upper extremity function	Can't bring hand to mouth: 18% (17% cervical injury) Able to bring 1 hand to the mouth: 82%
Independence for Oral Health	Can't do without help: 15% Needs help with set up or supervision: 12% Needs a special device or extra time: 8% Can brush w/o help: 65%
Daily oral habits	Brush: 84% Floss: 14% Mouth rinse: 48% Tobacco use: 33% Mouthstick use: 13%
Dental insurance	None: 50% Medicare/Medicaid: 26% Private: 24%
Health insurance	None: 2% Medicare: 5% Medicaid: 35% Private: 22% More than 1 of the above: 35% Workman's comp: 1%

Although many barriers pose a huge problem, lack of the actual perceived need appears to be the biggest barrier among people with special needs.<sup>32</sup> Research is still very limited on this topic. This study will add to the current literature on the perception people with SCIs have of their own oral health. Preventive services have contributed to the decrease in the incidence of dental disease over the years, therefore, this perception of perceived need must be changed.<sup>33</sup>

Table II: Oral Health Status Levels Determined By Oral Health Score (OHS) (n=92)

Descriptive Statistics of OHS					
		Frequency	%	Valid %	Cumulative %
Valid	91 to 100 – Good	17	18.5	18.5	18.5
	81 to 90 – Not that bad	27	29.3	29.3	47.8
	70 to 80 – Oral care and treatment is needed	19	20.7	20.7	68.5
	Below 70 – Oral cavity should be sorted out immediately	29	31.5	31.5	100.0
	Total	92	100	100	

## Methods and Materials

People with SCIs who received care at Mississippi Methodist Rehabilitation Center were asked to participate in a study to examine oral health status among Mississippians with SCIs. Only those who had obtained the spinal injury over 6 months prior to the exam were used. Approval for the research project was obtained through the institutional review boards of the University of Mississippi and Methodist Rehabilitation Center. People with SCIs having any heart/valve conditions following the 2007 American Heart Association guidelines were excluded from the study. Even though traditional dental treatment was not being provided to these individuals, placing a periodontal probe below the gingiva could cause unnecessary bacteria to enter into the bloodstream. In addition, individuals with SCIs and an artificial joint replacement within the last 2 years were also excluded from the study per the advisory statement issued by the American Dental Association and American Academy of Orthopedic Surgeons.<sup>34,35</sup> Exclusion criteria for this study were chosen to ensure the safety of participants and ensure that antibiotics were not used unnecessarily. For safety reasons, medical records were reviewed by the dental hygienist upon request. After informed consent was gathered, an oral survey and dental examination was given to a total of 92 individuals with SCI.

Indices used for dental evaluation were OHS, PSR™ and DMFT. The OHS consisted of 8 questions, each scored 0 to 20 points, that calculated a numerical measure of a patient's oral health status. Some questions were worth up to 20 points, while some a maximum of only 10 points. The total score ranged from 0 to 100 points. Each of the following categories were set according to the OHS guidelines provided by Denplan Excel practices (widely used in the United Kingdom) described as:

- Good (scores totaling over 90)
- "Not that bad" (scores ranging from 80 to 90)
- Treatment needed (scores ranging from 70 to 80)

Figure 1: Cross tabulation of people with SCI who thought their mouth was healthy, versus those who actually had a healthy mouth (n=92)

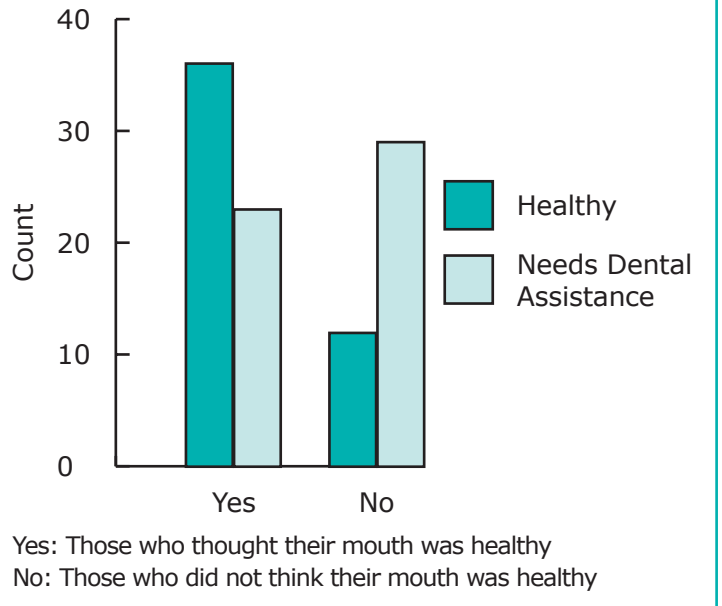


Table III: Hard Tissue Status Determined By Decayed, Missing, Filled Teeth DMFT (n=92)

Descriptive Statistics of DMFT					
	n	Minimum	Maximum	Mean	Standard Deviation
D score	92	0	24	2.83	4.571
M score	92	0	32	7.84	8.979
F score	92	0	22	4.14	4.985
DMFT	92	0	32	14.97	9.332

- Immediate care necessary (scores below 70)<sup>36</sup>

Raw OHS were also gathered and compared. Information gathered for OHS included patient comfort, assessment of caries (decay), assessment of wear, assessment of periodontal status, assessment of occlusion, assessment of mucosa and a general assessment of dentures if applicable. This outcome measure was selected because it included the pa-

tient's perception, provided a valid representation of oral health, granted easy use and required minimal training for administration.<sup>36</sup>

The DMFT score represents the number of teeth that exhibit caries in adults. To arrive at the overall DMFT score each tooth received a D for decay, an M for missing or an F for filled.<sup>37</sup> Scoring was based on 32 teeth with only 1 letter representing each tooth. If a tooth had been restored yet had additional decay the tooth was classified as a D. Scores were averaged and each participant received an average D score, M score and F score, as well as DMF score. The DMFT does not represent the extent of disease and is preferred for prevalence studies. Therefore, D, M and F were each measured independently.

Periodontal disease was measured by using the American Dental Association's PSR™, a modified community periodontal index of treatment needs, which measures gingival condition using a scoring scale of: healthy (0), presence of bleeding (1), presence of calculus deposits (2), presence of shallow pockets (3), presence of deep pockets (4), any abnormalities (such as recession above 3.5 mm, mobility and mucogingival involvement) (5, typically noted as PSR™'s asterisk) and edentulous patients (6, typically noted as PSR's x). Scores are calculated by using the worst or highest number per sextant (the oral cavity is divided into 6 portions). The need is then categorized into: no periodontal treatment is needed (0), oral hygiene is needed (1), professional cleaning is needed (2), oral hygiene instructions and professional cleaning are needed (3) and complex treatment (such as deep scaling by dental hygienist or referral to periodontist) is needed (4 and 5). A score of 6 that was given to those few patients that were completely edentulous indicated it was too late for periodontal treatment. This score was calculated by using the worst or highest score of all the sextants combined.<sup>38</sup>

In addition to the examination, a short survey asking demographic information and specifically

Figure 2: SCI patients who thought their mouth was healthy compared to Denplan categories (n=92)

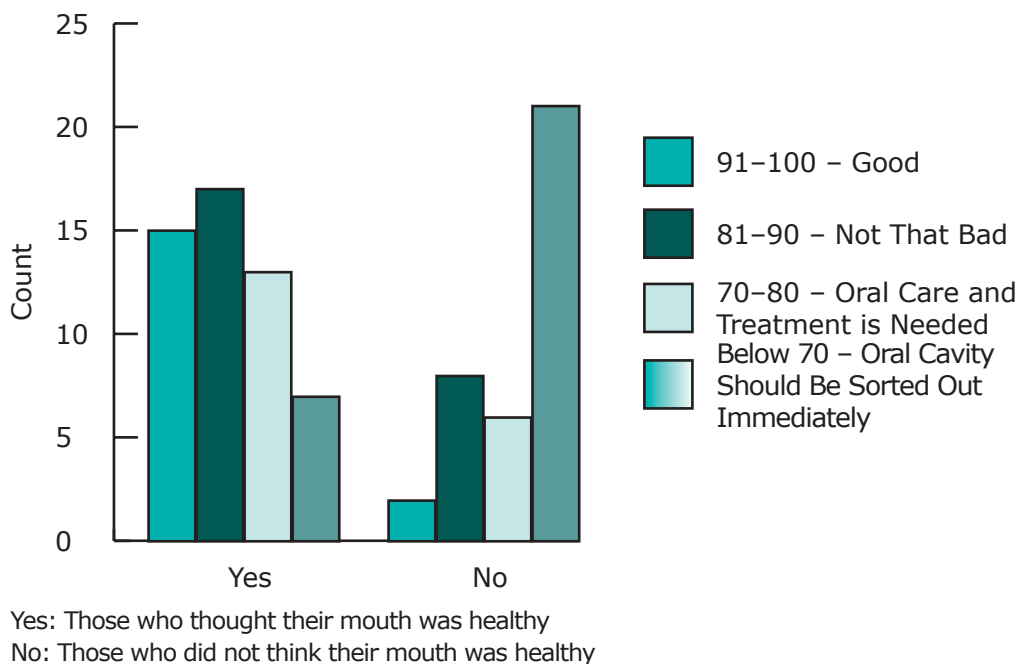


Figure 3: Compares how many SCI patients thought they had cavities to how many actually had cavities (n=92)

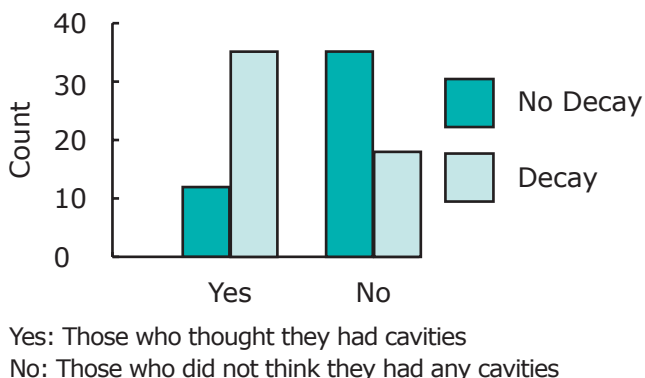
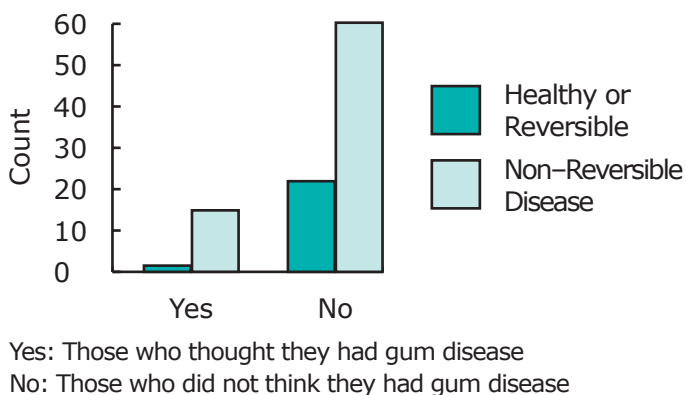


Figure 4: Cross tabulation that compares those with SCIs that thought they had gum disease to those who actually did have periodontal disease (n=92)





asking 3 perception questions was given. Questions were: do you think your mouth is healthy, do you think you have cavities and do you think you have gum disease? The survey questionnaire was deemed valid through a consensus of experts including a dentist, dental hygienist, rehabilitation researcher, rehabilitation nurse, occupational therapist and a statistician. From the survey, the hypothesis focused on how the SCI individual perceived their own dental health. Answers to each perception question were compared to OHS, DMFT, PSR™ and scores. This indicated the validity of SCI individuals' perception of oral health compared to dental professionals' assessments. Since perception is stated as one of the biggest barriers to dental care, such a comparison evaluated an awareness about the need for oral care among the SCI population.<sup>32</sup>

All data was uploaded into SPSS 16.0 for Windows and carefully examined. Frequencies, crosstabs and chi-squared were used to compare perceived oral status to the dependent variables of OHS, DMFT and PSR™. Records were kept anonymous and confidential.

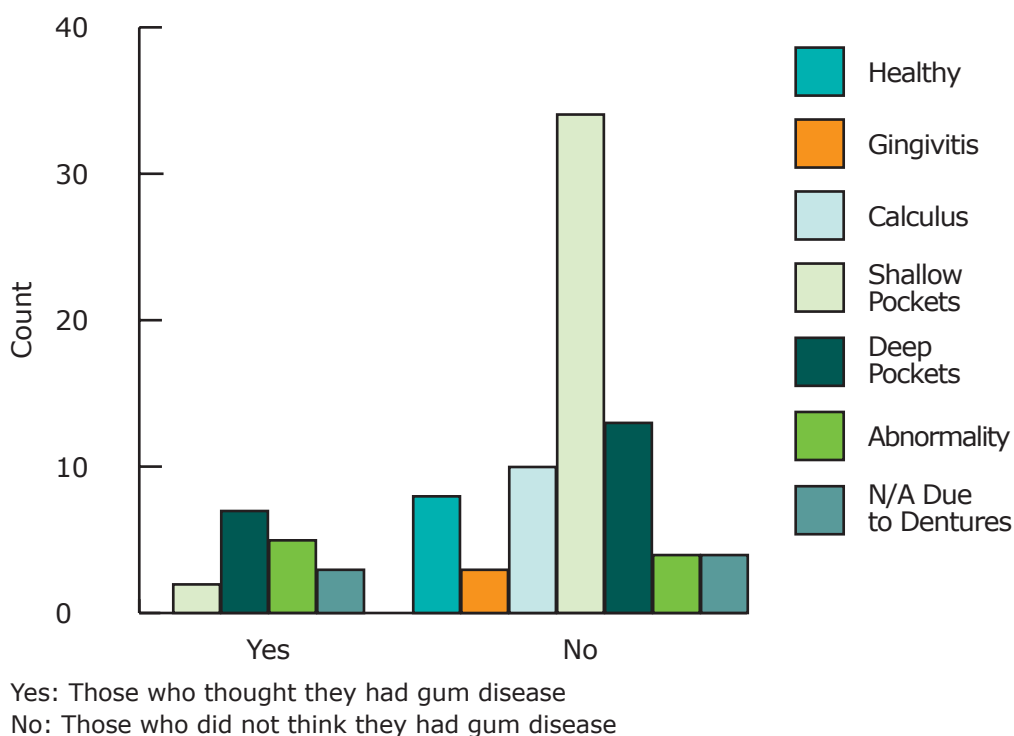
## Results

The study included 92 people with SCIs ages 18 to 71 who sustained their spinal injury a minimum of 6 months prior to appointment (Table I). People with SCIs perceived that their oral health status was better than it actually was (determined from examination scores by dental professional).

Table IV: Periodontal Status Determined By Periodontal Screen And Recording Index™ (PSR™) (n=92)

Descriptive Statistics of PSR					
		Frequency	%	Valid %	Cumulative %
Valid	Healthy	8	8.7	8.9	
	Gingivitis	2	2.2	2.2	8.9
	Calculus	11	12.0	12.2	11.1
	Shallow pockets	40	43.5	44.4	23.3
	Deep pockets	19	20.7	21.1	67.8
	Abnormality	6	6.5	6.7	88.9
	Not applicable due to dentures	4	4.3	4.4	95.6
	Total	90	97.8	100.0	100.0
Missing	System	2	2.2		
	Total	92	100.0		

Figure 5: Compares those with SCI that thought they had gum disease to individual categories within the PSR (n=92)



Of those surveyed, 59% perceived their mouth as healthy. However, according to the actual scores from the OHS index (Table II), only 47.8% were considered good to healthy (a score above 80). Of the 59% who perceived their mouth as healthy, only 36% actually were considered good to healthy. Using a cross tabulation and chi-square to analyze this data revealed that 23% of those who needed dental assistance thought their mouth was already healthy (Figures 1, 2).

Next, fewer people with SCIs thought they had caries (“Do you think you have cavities?”) when compared to the actual decayed portion to the DMFT score (Table III). Only 47% thought they had cavities, whereas 53% actually had decay observed visually without the use of radiographs, concluding that 18% were completely unaware they had clinically visual decay (Figure 3).

Finally, fewer people with SCIs thought they had gingivitis (“Do you think you have gum disease?”) than the actual PSR™ revealed. Only 16% thought they had gum disease, while over 75% actually had calculus, periodontal disease and/or gingivitis present (Table IV). Approximately 60% of those who thought they had no gum disease were already experiencing periodontal disease (Figures 4, 5).

## Discussion

This study provides a snapshot of the oral health status of people with SCIs in Mississippi. In all cases (perception of oral health, cavities and periodontal disease), people with SCIs thought their oral health was better than it was determined to be by a dental professional. One reason that guided this hypothesis was the assumption that people with SCIs may have other priorities than oral health. Indeed, functions endorsed as most relevant to SCI people include regaining arm and hand function, followed by sexual function, then bladder function and finally ability to exercise.<sup>39</sup> Most likely these functions were not met in the majority of our participants, leading to less emphasis on oral health and impaired judgment about seriousness of oral problems.

Little is known of how people actually perceive oral health. Among the general population, those who perceived their oral health as better are younger, more educated, of higher income, partial-less/denture-less, oral pain-free, symptom-free from dental problems and had visited the dental office

within the past year.<sup>40</sup> Future studies should include why people with SCIs perceive their oral health as better than it actually is.

Since people with SCIs do perceive their oral health as better than it actually is, health care providers need to do a better job of screening and relaying oral status to this population. Interdisciplinary collaboration must be incorporated.<sup>41</sup> Many nurses, occupational therapists, physical therapists and speech therapists are already screening the oral cavity and giving oral hygiene instructions. Where are the trained dental professionals/hygienists? In Mississippi, dental hygienists are not allowed to perform these duties without the direct supervision of a dentist. When compared to other states, Mississippi has one of the lowest dental hygiene professional practice index scores, which indicates that a revision to the dental hygiene practice statute is necessary to ensure better access to dental care.<sup>42</sup>

## Conclusion

This research has confirmed that people with SCIs need to be made aware of their dental status and educated on habits to promote oral health. Once again, preventive services that are usually provided by a dental hygienist contribute to a decrease in dental disease.<sup>33</sup> Once dental hygienists in this state and all states are allowed to provide services and/or screenings that they are trained to do, it will not be difficult to fight dental disease in people with SCIs.

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## Oral Health Students as Reflective Practitioners: Changing Patterns of Student Clinical Reflections over a Period of 12 Months

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### Introduction

The ideal contemporary oral health professional is a reflective and reflexive practitioner. To be reflexive is to evolve one's very being, one's self-awareness and mindfulness through self-examining one's actions within wider social contexts. In contrast, to be reflective is to transform one's ways of being through examining one's experiences and the experiences of others. The ability to reflect deeply and critically is a desirable attribute of the competent health professional.<sup>1-6</sup> Reflection is one of the highest extended abstract levels of learning and most indicative of deep learning according to the SOLO taxonomy.<sup>7</sup> Reflection is an important process of "learning to learn," which encompasses learning to interrogate, evaluate and make sense of experiences for learning, identify learning needs, self-direct learning, integrate different aspects of learning, integrate new and existing knowledge and skills and transform through learning.<sup>2,8-10</sup> Learning to learn has been described as "the greatest challenge facing education in the 21st century," so important that it cannot be left to develop implicitly.<sup>8</sup> The corollary to this is students must be taught the skills of reflection.<sup>11,12</sup> Yet critical reflective skills have traditionally been assumed to develop as a by-product of the learning process. This assumption has led to the underdevelopment of critical reflective skills.<sup>5,13-15</sup>

A lack of taught reflective learning in oral health programs (e.g. dental hygiene programs in the U.S., Australia and New Zealand) and dentistry

programs have been attributed to the assumption that critical reflection is difficult, if not impossible to teach and difficult to implement into traditional content-heavy curricula.<sup>2,4,13,14,16-21</sup> Moreover, teaching staff themselves may be unfamiliar with reflective learning as a pedagogical approach.<sup>2,13,17</sup> Students often perceive reflective practices negatively because "they don't know how" and deliberate reflective thinking seems too time consuming

### Abstract

**Purpose:** The purpose of this study was to determine the levels of reflection shown by bachelor of oral health students in relation to their clinical and professional practice.

**Methods:** Reflective learning was embedded as a topic in the oral health curriculum within the discipline of dental hygiene practice. Reflective journal writing was integrated with clinical practice and linked with assessment requirements. Students' reflective writing was analyzed thematically to elucidate levels of reflection based on Boud's 4 Rs of Reflection (review, react, relate and respond) over a period of 12 months. Differences in the levels of reflection at different time intervals were examined.

**Results:** Students' ability to critically reflect improved over the period of 12 months. The predominant level of reflection changed from primarily descriptive and superficial at the start of the academic year to primarily critical and relational by the end. As expected, the highest level of critical reflection (respond) occurred infrequently, although it became more frequent as the academic year progressed.

**Conclusion:** Bachelor of oral health students do reflect critically. Regular reflective writing contributed to the development of critical reflective skills in the context of clinical and professional development.

**Keywords:** Reflective learning, critical reflection, dental hygiene practice, oral health, clinical experiences, evolving professional

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



for very little gain.<sup>13,17</sup> Discrepancies also exist in the literature in relation to the definitions of reflection and critical reflection, types of reflection, models of reflection, levels of reflection, frames of references and contexts for applications, among others.<sup>2,22-30</sup> It is not difficult to understand why teaching and learning critical reflection may be challenging.

Not all reflections are created equal. Different types of reflection, different models of reflection and different levels of reflection have been proposed over the years.<sup>1,2,5,10,22-32</sup> Among these, Boud et al's model of reflection is commonly utilized in professional learning.<sup>23</sup> Boud et al described his model of reflection as the "totality of experiences of learners." Transformation of knowledge, skills and perspectives occur as a result of engaging the learner in affective, cognitive, analytical and transformative processes. In particular, key elements of critical reflection (association, integration, validation and appropriation) are developed.<sup>23,33</sup> Association refers to relating new knowledge/skills to the pre-existing. Integration refers to the formation of linkages among knowledge/skills. Validation refers to determining the authenticity of the feelings, ideas and perspectives that have resulted. Appropriation refers to internalizing new knowledge, skills, perspectives and ideas. Studies have shown that various reflective frameworks and worksheets based on different models of reflection are helpful to students and reported that structured reflection (via a framework) can assist students with processing thoughts and emotions and structuring and advancing the depth of their reflections.<sup>2,3,5,13,14,18,22-36</sup>

While reflective practices are utilized in oral health and dentistry, research in this area is limited.<sup>14,37-40</sup> In the systematic review conducted by Mann et al, of the 600 articles they identified as being related to reflection and reflective practice in medical or health professional education or practice between 1995 and 2005, only 29 papers qualified as being relevant for investigating "the process and outcomes of reflective practice in health professional education and practice."<sup>10</sup> Of these only 4 came from disciplines other than nursing and medicine. Research specifically targeted at investigating the levels of reflection that occur, the students' ability to reflect critically and deeply and the significance of reflective learning for clinical practice and professional development in oral health are yet to emerge.

The purpose of this study was to determine the levels of reflection shown by oral health students in their clinical reflective journals and to deter-

mine whether critical reflection, i.e. "the type of reflection that bring about transformations," contributed to the oral health students' clinical and professional development.<sup>2,29,41,42</sup>

## Methods and Materials

**Participants:** The educational intervention was embedded into the dental hygiene practice course in the final year of the Bachelor of Oral Health program at the University of Queensland. The program graduates students as oral health therapists and qualifies students to become registrable as both dental therapists and dental hygienists in Australia and New Zealand. Dental hygiene practice constitutes one of the key streams of clinical practice. In contrast, in the U.S., specific dental hygiene programs, studied at a certificate, bachelor or masters level, qualify graduates specifically as dental hygienists. University qualified dental therapists currently do not exist in the U.S., although dental health aid therapists are being utilized in some states, such as Alaska, to provide dental care to the underserved communities.

All bachelor of oral health students in their final year are required to enroll in this compulsory year long course. In total, 17 oral health therapy final year students (all females) participated in the intervention. Written informed consent was obtained from all 17 students. The study was approved by the University of Queensland Medical Research Ethics Committee.

**The Intervention:** The program did not provide students with knowledge and training in reflective learning and reflective practices. Previously, critical reflection was assumed to occur as students progressed through the program and matured. Most students in the program have not had exposure to reflective skills training or critical reflection. Hence, students were introduced to the concepts of reflective learning and reflective writing at the start of the semester via 2 seminars. In particular, different levels of reflection were discussed, examples of critical reflection versus surface reflection were examined and students were provided with a structured reflective proforma to focus their clinical reflective efforts and to assist with the development of systematic, in-depth reflections. The proforma followed Boud's 4 Rs of Reflection (revisit, react, relate, respond) (Table I).<sup>23,26,43,44</sup> Students were encouraged to utilize this proforma but not mandated.

Clinical practice constitutes approximately 60% of the final year of the dental hygiene practice course. Students attend 2 dental hygiene practice clinical sessions each week. Each clinical session

Table II: Examples of different levels of student reflections from Semester 1 (Wk10S1) and Semester 2 (Wk8S2, Wk12S2)

Steps/Levels	Examples
REVISIT	<ul style="list-style-type: none"> <li>• (Wk10S1) Today I had a small disaster with the second patient who had a root filled tooth and it fractured at the gingival margin just as I was refining my debridement.</li> <li>• (Wk8S2) I learnt all about removing sutures and periodontal dressings this week.</li> <li>• (Wk12S2) I had one of my favourite patients in for a review today, she is just about to start chemotherapy...</li> </ul>
REACT	<ul style="list-style-type: none"> <li>• (Wk10S1) I quietly had a "panic attack" as I waited for the tutor to come. To make matters worse, it was her daughter's wedding that Friday night! ... Thank goodness for supervisors!!!</li> <li>• (Wk8S2) Got the shock of my life when I got to remove sutures for a perio postgrad this afternoon!!! I didn't expect to put this into practice sooo soon. Scary...even now it is scary.</li> <li>• (Wk12S2) I was glad to be able to see her before she started her chemotherapy.</li> </ul>
RELATE	<ul style="list-style-type: none"> <li>• (Wk10S1) It was quite a horrible experience especially in explaining what had happened to the patient and realizing that I didn't quite know enough about root canal treated teeth. We eventually decided to refer her to clinic 7b for a consult and temporary treatment.</li> <li>• (Wk12S2) I was very glad that we were given lectures on cancer patients and how this affects their oral health and oral hygiene. This was great as I was able to apply my theory into clinical practice... It was a great opportunity to encourage good OH before undergoing such a horrible experience... that way it's not another thing to have to worry about when the patient already has so much on their mind.</li> </ul>
RESPOND	<ul style="list-style-type: none"> <li>• (Wk8S2) I need to learn more about sutures and periodontal dressings i.e. indications, different types etc. I might just have to do that again in the "real patient."</li> <li>• (Wk12S2) My patient's worried about the possibility of mucositis during and after "chemo." I tried to reassure her but realised how hard it could be for her. I want to find out all I can about mucositis especially current treatment so I can offer her better? more realistic? advice next time. I wonder if I'm in a position professionally/legally to help manage her mucositis? I will find out.</li> </ul>

lasts 3 hours and involves students providing risk assessment, oral health education, oral hygiene instruction and dental hygiene treatment (quadrant debridement under local anaesthesia, restoration recontouring, etc.) to 3 patients within the School of Dentistry Undergraduate Dental Clinics. In addition, students are rotated throughout the semester into specialty clinics for extraoral radiography and orthodontics as part of course requirement for dental hygiene practice.

On the basis of developing students as reflective practitioners and purposefully optimizing clinical practice, professional development and self-directed learning, students were required to keep a clinical reflective journal noting specific critical incidents that contributed to their clinical learning on a weekly basis. Reflective journaling was selected as the reflective practice of choice as students were able to complete their reflection independently and in their own time. It was intended that privacy and a sense of security would encourage openness. Students were not limited to critical incidents that occurred in dental hygiene practice. Students were provided with guidelines to assist with their reflections, including the definition of a critical incident and recommended length of time to be devoted to

reflection per week. Students were asked to submit a word processed version of their clinical reflective journal and were invited to submit their reflective journal to the course coordinator periodically for feedback. Feedback was provided informally via personal emails to individual students and formally via one-to-one interview appointments.

The reflective journals were submitted at the end of each semester as part of the students' required assessment. The assessment of the reflective journals were based on the rationale that assessed task conveys importance to students. Reflective journals were graded pass or fail. The submission of a journal containing weekly reflections based on critical incidents resulted in a pass grade. A lack of reflective entries or submission of entries that were not based on critical incidents resulted in a fail grade. Written comments, both positive and negative, as well as responses to questions raised by students in their reflection, were provided in each student's reflective journal.

**Data analysis:** Students' reflective writing were analyzed thematically at different time intervals, with the aid of Leximancer (v2.25), a lexical software.<sup>45</sup> Leximancer provides "automatic content

and thematic analysis” by objectively analyzing the content of text, beginning with identification of keywords. The list of these keywords can be modified if needed to create a thesaurus-based set of concepts or themes from the textual data, without the need for a prior dictionary. Manual concept seeding may also be performed alongside the automated process. In brief, concepts represent groups of keywords that occur in close proximity that describe an idea. Keywords are weighted according to the frequency of occurrence within each text unit containing the concept compared to the frequency elsewhere. A concept is marked only if the sum of the weights of the keywords found is above a preset threshold. The thesaurus function enables concept editing by merging similar concepts into a single concept, defining context-specific concepts, deleting concepts and/or creating concepts to facilitate different perspectives. Themes represent a summary of concepts determined based on co-occurrence. The frequency of co-occurrence between concepts is determined, and the concepts and themes are then classified and a concept map is generated from an asymmetric concept co-occurrence matrix to aid in analysis and interpretation. Concepts are contextually clustered on the concept map and located in relation to theme circles that cluster related concepts. Concept maps are constructed multiple times to ensure consistent trends and validity. In addition, a thematic summary representing ranked concepts, connectivity and relevance numerically is generated to complement each concept map. The reliability of the coding is based on mathematical algorithms used in the software.<sup>45</sup>

Boud et al’s model of reflection was used as the basis of analysis.<sup>23,26</sup> This model was chosen because students were provided with a reflective writing guideline based on the Boud et al model.<sup>23,26,43,44</sup> Students’ reflective writings were processed using Leximancer to produce a list of automatic key concepts and themes. These were reviewed to ensure relevance and edited via manual concept seeding. From these, a thesaurus-based set of concepts and themes were organized. Concepts were categorized using the Leximancer thesaurus function into revisit, react, relate and/or respond. Revisit referred to basic reflection that involved recapturing and recollecting the experience. React referred to reflections that addressed the affective aspects associated with the experience and provided reasons for actions. Relate involved reflections that assessed, related and integrated new and pre-existing perceptions, concepts and understanding. Respond referred to reflections that evaluate and validate the authenticity of the new perspectives, leading to personalization and transformation in

thought, understanding and action. Classification using this reflective model was repeated 3 times to ensure validity and a concept map to be created. A thematic summary report was also produced detailing key concepts and themes, frequency of occurrence, connectivity and relevance. A concept map and its associated thematic summary report was created for each time interval and compared to determine changes in students’ levels of reflection over the 12 month period.

In addition, the levels of reflection were examined as a percentage of total reflections at designated time intervals. The change in reflection level (descriptive versus critical) in Week 1 Semester 1 versus Week 12 Semester 2 was analyzed.

## Results

Thematic analysis of students’ reflective journal entries (n=1,000 text units) indicated that students reflected across all 4 levels of reflection. The frequency of the 4 levels of reflections differed from student to student and from semester 1 to semester 2.

**Semester 1:** When students first began writing reflectively, much of the reflections were basic, i.e. revisited and recollected experiences that were descriptive (61% of total reflection in Week 1 and 68% in Week 5) (Table II). The reflections were mainly about students’ experience in terms of what they did in their clinical sessions: patient management, treatments, clinical examinations and time management.

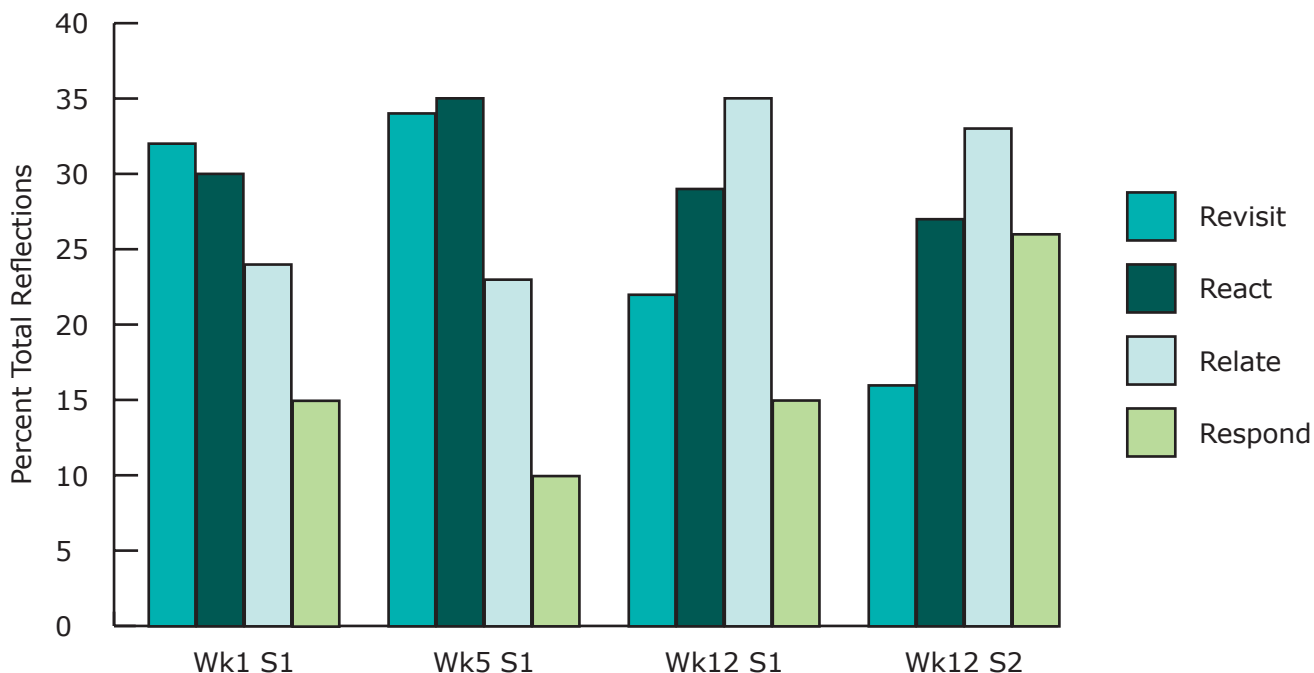
By Week 12 of semester 1, students were reflecting more deeply about their clinical experiences and much of their critical reflections were relational (35% of total reflection in Week 12). Their reflections assessed, related and integrated new perceptions, concepts and understanding to pre-existing perceptions, concepts and understanding to produce new perspectives (Table II). The reflections were populated with greater frequencies of relational concepts such as “thinking” and “finding.” In contrast, the highest level of reflection remained a relatively small component of the students’ reflection throughout semester 1 (15% in Week 1, 10% in Week 5 and 15% in Week 12). The total percentages of reflection that were descriptive (revisit and react) versus critical (relate and respond) were approximately equal at 50% respectively.

**Semester 2:** By the end of semester 2, students devoted less of their reflections on revisiting and reacting to their experiences (16% and 26%, respectively). By week 12 of semester 2, much of their reflections continued to be relational (32%).

Table I: The 4 R reflective framework based on Boud et al's model of reflection<sup>23,24,43,44</sup>

Steps/Levels	Action	Guiding Questions
REVISIT	Recall experience To record	<ul style="list-style-type: none"> <li>• What did you do in your clinical session?</li> <li>• Were there any particular event(s) that made an impact on you?</li> </ul>
REACT	Affective To feel	<ul style="list-style-type: none"> <li>• How did the session/event(s) make you feel?</li> <li>• As you re-examine the particular event(s), how do you feel now?</li> </ul>
RELATE	Cognitive To think To associate To integrate To validate	<ul style="list-style-type: none"> <li>• What event(s) did you learn the most from and why?</li> <li>• What did you learn most about?</li> <li>• How can you relate your experience/event(s) to what you learn in other courses/experiences?</li> <li>• How does the event(s) help you to learn?</li> <li>• How does the event(s) further your understanding e.g. clinical/professional?</li> </ul>
RESPOND	Psychomotor To do To appropriate To transform	<ul style="list-style-type: none"> <li>• How will the learning gained from the event(s) help you in your profession?</li> <li>• Can you think of any alternative or new approaches of doing things better? differently?</li> <li>• What do you expect to do better next time?</li> <li>• Any questions? Learning goals?</li> <li>• Did the event(s) change your perspectives? If so what changed and how?</li> <li>• What can you change/how can you improve?</li> <li>• How will you go about making changes/learn?</li> </ul>

Figure 1: Differences in Students' Levels of Reflections Over a Period of 12 Months



A significantly greater proportion of their reflections were responsive (26%), i.e. students valued and validated the authenticity of their new perspectives, personalized them, resulted in changes or transformation in thought or understanding and action (Table II, Figure 1). Concepts such as relate, respond and goal appeared more frequently

compared to semester 1. The proportion of critical (relate and respond) reflection (58%) was greater than descriptive (revisit and react) reflection (42%).

**Changes in Reflective Levels:** Differences in the levels of reflection over the 12 months were

examined as a percentage of total reflections at designated time intervals (Figure 1). Mixed levels of reflection were utilized by students at any one time, often with a dominance of 1 or 2 levels. The rate of progress differed from student to student. The highest level of reflection (respond) was the slowest to improve overall but showed the biggest change in frequency across the semesters, especially in semester 2.

The students' reflection writings in week 1 semester 1 contrasted with those submitted in week 12 semester 2. At week 1 semester 1, 61% of reflection was at the descriptive level. By week 12 semester 2, 58% of total reflection was critical reflection (i.e. relate and response levels). Throughout the 12 month period, the percentage of total reflections that was attributed to the highest level of reflection (respond) remained relatively low (8 to 26%) (Figure 1). Largely, critical reflections performed by students in this study were relational in nature (31 to 58%).

**Usefulness of a Reflective Framework:** Reflective entries which utilized Boud et al's guided framework were compared to those that did not, in relation to level of reflection. Overall, entries which utilized a framework did not demonstrate higher levels of reflection.

**Relevance of Feedback and Guidance:** The frequency of feedback and guidance sought by students were also compared, in relation to the frequency of higher levels reflection. In this study, students who sought feedback and guidance frequently submitted their reflective writing voluntarily for feedback during the semesters and also tended to demonstrate higher levels of reflection.

## Discussion

Much has been written about reflective learning in the health sciences in general. The focus of this study was on critical clinical reflection in oral health therapy within the discipline of dental hygiene practice. While it is often assumed that oral health and dental students have the ability to reflect, the depth of their reflections and the effectiveness of their reflections are much less researched. The purpose of this paper was to explore the significance of reflective learning in bachelor of oral health students in relation to clinical and professional development. The evidence suggests that oral health therapy students reflect through a range of levels but that critical reflection occurs relatively infrequently, was not automatic, required deliberate effort and had a tendency to develop later, perhaps only after some clinical exposure and when students felt comfortable and confident with the

process of reflecting upon a critical incident. These findings support the idea that reflection is a learned process and that reflective skills do not develop as a natural by-product of time, experience or education.<sup>2,5,13,19,23,24,26,32,34</sup> These findings also concur that the transformational forms of reflection occur rarely and usually as a part of experiential learning.<sup>2,4,5,10,13,16,39-41</sup> Given that the ability to critically reflect is desirable, the above findings support the early introduction of clinical practice into the oral health curriculum. As Wetherell et al stated, "What we are endeavouring to do is to create knowledge through the transformation of experience. For the students, their experiences in the clinic are being transformed by the records in their journal."<sup>37</sup>

The key characteristics of critical reflections are the element of transformation (perspective, contextual and meaning) and the construction of explicit knowledge from what is implicit or intuitive to our actions, leading to improved actions.<sup>24,29,32,33</sup> Bachelor of oral health students reflected most critically when an experience impacted upon them in some way. Contrarily, students found it difficult to reflect deeply when they perceive their experiences to be routine. This is of significance to oral health educators. In assisting students in their clinical and professional development, the curriculum must not simply implement early clinical exposure but offer clinical learning experiences that are challenging enough to make an impact, so that students see the need to "move from describing an event to reflection on events and analyses of their reactions and actions."<sup>34</sup> Repetitive clinical experiences perceived by students as routine tend to retard critical reflection, resulting in practices that are mechanistic and protocol-driven – perspectives remain unchanged and innovations never eventuate.<sup>2,18,23,29,30,44</sup> On the other hand, experiences that take students out of their comfort zone tend to drive critical reflection as part of the sense making, meaning making, internationalization processes.<sup>2,18,23,29,30,44,46</sup> Clearly, we as educators must also be mindful that "It is engagement with an event that constitutes a learning experience," and that it is reflection coupled with experience that leads to translation and transformation of learning.<sup>44</sup> Simply doing a reflective journal because a student is asked to does not constitute engagement, and thus do learning is not expected to occur, even in the midst of the most exhilarating clinical experience.

The rate of improvement and the timing when the proportion of reflection changed from mostly descriptive to critical level differed among the students and could be traced to a particular time interval in this study. This is in contrast to the findings of Landeen et al who pinpointed that the



shift from journaling non-reflectively to journaling reflectively usually required only a few weeks in the presence of faculty feedback and guidance.<sup>34</sup> Other studies also articulated the importance of "more guidance, critique, feedback and reinforcement"<sup>2,5,29,35,46,47</sup> While this study did not examine the impact of feedback on students' progress in critical reflection in detail, students who submitted their journals voluntarily during the semester for feedback tended to demonstrate higher levels of reflection. Feedback was provided to students to encourage sustained efforts, to build trust and to stimulate different perspectives. The availability and method of feedback and guidance should be considered when designing reflective learning into the curriculum. The adoption of "a wide and multidimensional perspective in dealing with issues at hand"<sup>33</sup> and contextual examination of thoughts, feelings and actions<sup>3,26,44</sup> are enhanced by prompting, feedback and guidance.<sup>2,5,46,48</sup> In addition, the process of positive feedback and guidance may contribute to a learning environment conducive to the development of critical reflective skills, an environment in which students can expect help rather than criticism and feel safe to disclose their inner thoughts without consequence or prejudice.<sup>2,5,46,48</sup>

In this study, students' critical reflections consisted primarily of relational reflections. Responsive reflections – the highest level of reflection, remained relatively low. This is to be expected as the kind of reflections that bring about transformation and innovation is difficult to achieve and requires the occurrence of incidents of substantial impact.<sup>5</sup> Expectations that all undergraduate students will consistently reflect at the highest level of reflection would therefore be unrealistic and impractical. Instead, emphasis should be placed upon developing students as reflective practitioners, who are able to self-evaluate and self-direct their learning post-graduation and thus ascertain professional quality assurance. Moreover, it has been suggested that the lack of reflection may have a negative impact on learning.<sup>2,41</sup> It is posited that rationalizing explicitly the necessity of developing critical reflective skills to students coupled with educators and curricula that constantly push students to think critically and to engage issues in more critically reflective ways may be one way of optimizing the reflective aspect of learning to learn.<sup>40,41</sup>

Furthermore, students in this study were introduced to a reflective framework based on Boud et al's model of reflection (Table I).<sup>23</sup> Boud et al's model of reflection was selected because of its simplicity and cumulative style. It was thought that students utilizing the framework for reflection would reflect progressively through the levels to reach the trans-

formational form of critical reflection. However, in this study, reflective writing which utilized Boud et al's framework did not always lead to more critical reflections compared to reflective writing that were not guided by the framework. From this it is evident that a guided framework is one approach of assisting students in developing reflective skills – it is not necessarily going to result in superior quality reflections.

Several limitations were identified. Firstly, the reflective journals were graded, albeit pass or fail. Boud noted the purpose constraints the form of the reflective piece and assessment imposes on the students' freedom to express honestly and completely their thoughts, concerns and uncertainties, and to focus on what they do not know, which drives reflective learning.<sup>44</sup> Secondly, the number of students in this study was few and therefore limiting the generalizability of the results. Thirdly, it was difficult to determine to what extent the students' improvement in critical reflection was a result of increased clinical experience, provision of feedback and guidance, natural maturation and development through the learning process, as opposed to the direct effect of having practiced critical reflection. Fourthly, this study examined only reflective writing and therefore it was not possible to take into account non-written critical reflection conducted by students. High levels of reflection can take place without students representing these reflections in writing. Hanson et al suggested that reflecting electronically produced more superior reflection than hard copy reflective journaling.<sup>40</sup> It may be worthwhile in future studies to elucidate whether different media (electronic reflective blogging versus hard copy reflective journaling, group reflective discussion versus independent reflective writing) influences the development of reflective skills and the quality of reflection.

To assist in optimizing the skills of critical reflection and reflective learning in the clinical context amongst oral health students, follow-up studies with greater sample sizes and longitudinal data are being collected to further explore reflective learning in oral health. Further investigation into the outcome measures by which competence in critical reflection is determined and to what extent the roles of learning context, regular feedback and the nature of feedback, as well as consistent practice, play in developing critical reflective skills would also be beneficial. In addition, insights into how practicing oral health therapists, dental hygienists and dental therapists utilize critical reflections in the clinical and professional context would also be of interest.

## Conclusion

Oral health students in this study demonstrated that they were able to critically reflect. However, the ability to reflect critically and deeply did not come about instantaneously and therefore should not be assumed to occur as a natural by-product of the professional education process. Critical reflection occurred infrequently among the oral health students, but when it does occur it adds substantially to personal learning and gaining of insights. Reflective skills tended to improve at varying rate and at varying times, suggesting that the development of

critical reflection may be dependent upon exposure to a variety of challenging clinical and professional experiences and the availability of feedback and guidance, rather than simply over time. The results of this study support the continued development of reflective learning in oral health, within both dental hygiene practice and dental therapy practice.

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## Comparing the Risk Identification and Management Behaviors between Oral Health Providers for Patients with Diabetes

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### Introduction

According to the most recent data from the Centers for Disease Control and Prevention, it is estimated that 23.6 million Americans, or over 7.8% of the adult population, are affected by diabetes.<sup>1</sup> Over the past 35 years, diabetes prevalence has increased 3-fold.<sup>2</sup> In 2007, 1.6 million new cases of diabetes were diagnosed in people aged 20 and older.<sup>1</sup> While this increase in diagnosed cases of diabetes is alarming, the estimated 5.7 million undiagnosed cases is an additional cause for concern.<sup>1</sup> With the increase of diabetes, dental practitioners will be treating more patients with diabetes in the future.

Recent evidence supporting the link between periodontal and systemic diseases, such as diabetes, continues to increase in the medical, nursing and dental literature. Diabetes mellitus can modify the manifestation and progression of periodontitis and is considered the most significant systemic disease risk factor for periodontitis,<sup>3-13</sup> while periodontitis is often considered the sixth complication of diabetes.<sup>14,15</sup> Additionally, several studies suggest a bi-directional relationship between periodontal inflammation and glycemic control. Patients with poor glycemic control exhibit increased attachment loss and unfavorable response to periodontal therapy.<sup>2-13</sup> Taylor et al provides evidence from treatment studies supporting an association between poor glycemic control in people with diabetes and increased occurrence and progression of peri-

odontal infection or periodontitis.<sup>2</sup> Type 2 diabetes and periodontal disease are both chronic diseases which require considerable patient education and substantial self-management skills to achieve good outcomes. In poorly controlled diabetes, the degree of periodontal destruction is often greater and the

### Abstract

**Purpose:** Evidence supporting the link between periodontal disease and systemic disease continues to grow. To date, little is known about how dental professionals incorporate this information into managing diabetic patients. This study examines the risk identification and practice behaviors regarding diabetic patients among dentists, hygienists and specialists.

**Methods:** Responses were received from 383 currently practicing oral health professionals in Arkansas. The electronic survey consisted of 35 open and closed-ended or Likert-type items. Principal components factor analysis using varimax rotation was used to explore underlying dimensions of the questionnaire in order to provide a more parsimonious view of the outcomes. Logistic models were fitted to determine best practice outcome as a function of knowledge and professional and social norms.

**Results:** Neither knowledge about diabetes ( $p < 0.285$ ) nor provider type ( $p < 0.186$ ) was a predictor of practice behavior. Professional and social norms ( $p < 0.001$ ) identified those practitioners who felt modifying their management strategies for their patients with diabetes was a necessary component of their practice behavior.

**Conclusion:** In general, risk assessment was lacking, irrespective of whether a clinician was a dentist or dental hygienist. Results indicate oral health professionals in Arkansas need to improve the treatment and management of patients with diabetes and periodontal disease.

**Keywords:** Glycemic control, HbA1c, syndemic, insulin resistance, hypoglycemia, glycated hemoglobin, periodontitis

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number of teeth affected is higher, often making the diabetic patient more difficult to treat.<sup>16</sup> Diabetes can exaggerate the host response to the oral microbial factors, resulting in unusually destructive periodontal breakdown. Poorly controlled diabetics have a greater risk of progressive alveolar bone loss and connective tissue attachment loss than those patients with well controlled conditions.<sup>16-21</sup> In addition to maintaining oral health, treating periodontal infection in people with diabetes may play an important role in establishing and maintaining glycemic control. It is important to note that an improvement in glycemic control after periodontal treatment was not reported by all investigations.<sup>2</sup>

Because diabetes mellitus is considered the most significant systemic disease risk factor for periodontitis,<sup>3-13</sup> teaching blood glucose screening to dental students has been suggested as an intervention to improve diabetes outcomes.<sup>22</sup> This initiative is in harmony with the 1995 Institute of Medicine's Committee on the Future of Dental Education Study, which states that "dental education has arrived at a crossroads," and the position of dental education is being questioned as is its relationship to medicine and the larger health care system.<sup>23</sup> The Institute of Medicine's report noted the need to broaden the knowledge about oral health care problems as they relate to systemic disease and to improve understanding among general dental practitioners in active management of systemic diseases such as diabetes.

A risk assessment (process of care indicator) in the diabetic patient that is of importance to the oral health professional is the HbA1C (glycated hemoglobin) test, or A1C test.<sup>24</sup> Hemoglobin, which is found in red blood cells, links with the glucose in the blood to become glycated.<sup>25</sup> Once glycated, the hemoglobin will stay glycated for the entire lifespan of the red blood cell, approximately 120 days. Random blood glucose testing gives only a snapshot of the glucose levels at a single moment in time and is critically dependent on the time and carbohydrate content of the previous meal.<sup>25</sup> The HbA1c level provides a measure of glucose management over the last 2 to 3 months. An improvement or worsening in blood glucose level will take 2 to 3 months to produce a change in the HbA1C reading. Figure 1 illustrates how blood glucose and HbA1c (glycated hemoglobin) levels compare. A 9% level means that 9% of hemoglobin molecules are glycated (sugar coated). People without diabetes have an approximately 5% reading. Research has shown that keeping the HbA1C less than 7% helps lower one's risk for the complications of diabetes.<sup>25</sup> An 8 to 10% HbA1c is usually considered moderate glycemic control, while >10% is considered poor

control.<sup>16,25</sup> Physician intervention is indicated with readings >8%.<sup>19,20</sup> The American Diabetes Association Guidelines recommend that people with diabetes try to maintain glucose levels close to normal and to keep the HbA1C value at <7%.<sup>25</sup> Current evidence suggests that dental professionals need to be aware of this linkage and appropriately modify assessments and treatment plans to address the diabetic individuals' needs.

Risk assessment is now an integral component and the standard of care for assessing and managing periodontal diseases.<sup>26-27</sup> Type 2 diabetes, as one of the most important systemic disease risk factors for periodontitis, plays an important role in patient assessment, diagnosis, comprehensive treatment planning and health promotion and disease prevention.<sup>9</sup> To date, little is known about the degree to which oral health professionals have modified their practice behaviors to adapt to the emerging evidence for the bi-directional relationship between diabetes and periodontal disease.

In 2006, Kunzel et al surveyed active periodontists and general practice dentists in the Northeastern U.S. to determine the extent to which the dentists' behaviors and attitudes reflect current understanding of diabetes and smoking as important systemic disease risk factors for periodontitis.<sup>9</sup> This survey was the first to document the extent of dentists' behaviors with respect to the assessment and management of the diabetic or unidentified diabetic patient.<sup>9</sup> The survey elicited a high response rate (73% for periodontists and 80% for general practice dentists) among a relatively small sample (n=274). Results showed that there was a deficit in clinicians' behaviors, specifically in: determining type of diabetes, when first diagnosed, complications (if any), regimen utilized to control blood glucose, referring for/monitoring glucose levels, communicating with patient's physician, changing/adjusting frequency of dental visits, discussing post operative medications/infection control, discussing

Figure 1: Correlation between HbA1c levels and mean plasma glucose levels

HbA1c (%)	Mean plasma glucose levels <sup>a</sup>
6	126
7	154
8	182
9	212
10	240
11	269
12	298

Normal blood glucose levels for a person without diabetes: Fasting 95 mg/dl or less, one hour post prandial 140 mg/dl or less, two hours post prandial 120mg/dl or less.

level of glycemic control, oral implications and how periodontal treatment may affect glycemic control. Moreover, a greater number of clinicians reported more frequently assessing and/or advising smokers than proactively managing the diabetic patient.<sup>9</sup>

While these results are interesting, the sample did not include dental hygienists. Patients who see their dental hygienists on a regular basis often form relationships and establish a meaningful rapport. Dental hygienists have the potential to influence the patient's attitude and knowledge regarding the link between diabetes and periodontal disease.<sup>28</sup> Dental hygienists also monitor the patient's periodontal health and play a key role in detecting changes that may be related to systemic disease.<sup>29</sup> In support of an interdisciplinary approach, all oral health professionals should offer support in the assessment and proactive management of diabetes and periodontal disease.

The purpose of this study was to compare the risk identification and practice management behaviors between various types of oral health providers for patients with diabetes.

## Methods and Materials

In April 2009, a convenience sample of 1,819 practicing general dentists, periodontists and dental hygienists with current, valid email addresses in Arkansas were surveyed using a 4 page structured electronic survey instrument (Survey Monkey). The email addresses were obtained from the Arkansas State Board of Dental Examiners. Currently in Arkansas, there are 1,341 licensed dentists (1,178 practicing in Arkansas) and 1,320 licensed hygienists (1,194 practicing in Arkansas). The survey was sent via email with a cover letter that explained the purpose of the study and invited interested subjects to participate. After the initial invitation to participate in the survey, the survey was available for 3 weeks, with follow up reminders emailed to the non-respondents after 1 week and again 2 weeks later. Professionals practicing less than 1 day per week were excluded. The Social Science Institutional Review Board for the University of Missouri-Kansas City (UMKC), Kansas City, Missouri approved this research.

A survey instrument was developed based on a modification of an existing survey instrument used by Kunzel.<sup>9</sup> The modified survey asked dentists, periodontists and dental hygienists to describe the extent to which they assess patients for diabetes (diagnosed and undiagnosed), as well as the manner in which they evaluate and manage patients with a history of diabetes and who present with periodontal disease. The survey contained 29 Lik-

ert-type scale questions, 3 open and closed-ended questions, as well as demographics such as training (dentist, hygienist, periodontist) and years in practice. Nine questions addressed risk identification, 8 addressed risk management, 6 addressed practice behavior and 6 addressed self-assessed knowledge and confidence in these areas. Three open-ended questions requested oral health professionals to define barriers, if any, to incorporating an interdisciplinary approach to treatment of patients with type 2 diabetes. Respondents were also asked to quantify how often they read current peer reviewed literature/research. A pilot test of the survey instrument was conducted by a panel of expert dentists, periodontists and hygienists, among the UMKC School of Dentistry faculty, to ensure that the items and response categories were appropriate for identified domains.

Data were analyzed using descriptive and inferential statistics. Results were obtained from Survey Monkey, coded and transferred to Excel and imported into SPSS. Principal components factor analysis with varimax rotation was used to explore the underlying dimensions of the questionnaire in order to provide a more parsimonious view of the outcomes. Subsequently, subscale scores were computed as mean scores and used in comparative analyses. Analyses were conducted at the group level where categorical variables, such as years in practice and type of provider, were used as grouping variables.

Additionally, clinicians were dichotomously grouped into those who employ current standards of care for managing diabetics and those who do not. Current standards of care were determined by correct responses to the following questions:

- Specify the type of diabetes
- Specify when they were diagnosed
- Specify what regimen they use to control blood glucose
- Refer for and/or monitor glucose level
- Perform medical consults with the patients physician
- Change/adjust frequency of dental visits
- Discuss postoperative medications and/or infection control
- Discuss how well controlled their diabetes is
- Discuss oral implications of diabetes
- Discuss how treatment may affect glycemic control

Never, rarely, sometimes, very often and always were the response choices, with the correct response being "always." Predictive models were tested using logistic regression to explore signifi-

cant predictors of management behavior. An alpha of 0.05 was used to determine statistical significance.

## Results

Out of the 1,819 that comprised the sample, 383 participants opened the survey online, with 318 completing the survey for a response rate of 17.4%. One hundred and sixty-five (60%) were dental hygienists, 106 (38.5%) were general dentists and 5 (1.5%) identified their profession as periodontist (or other). Due to the low proportion and response rate of periodontists, only descriptive data are provided for this group. The majority of respondents had more than 20 years of experience. The majority of dental hygienists indicated reading 1 journal a week, while most dentists read 2 to 3. Table I and II show the percentages of years in practice and number of journals read for the respondents.

Overall, there were 9 survey items pertaining to risk identification. Risk identification was further characterized by dichotomizing items as general risk identification or specific diabetes risk identification. General risk identification questions addressed the frequency of patient's medical history updates, presence of diabetes, if the patient is under the care of a physician and medications taken. Specific diabetes risk identification questions consisted of: when diagnosed, type of diabetes, family history of diabetes, current HbA1c, glycated hemoglobin levels and a checklist of how frequently patients were asked about regimens used to control blood glucose. A large majority of dentists and hygienists (>89%) queried their patients regarding the following 3 risk identification items: presence of diabetes, under care of a physician and medications taken. More dentists (56.9%) than dental hygienists (35.75%) questioned their patient regarding a family history of diabetes. The responses to risk identification are presented in Table III.

Only 1.9% of total responses reported that they rarely perform a complete medical history update for their patients. Despite routine history taking, remarkably few providers (12.1%) ask for patient's HbA1c, glycated hemoglobin level. For this question, only 10.8% of dentists and 8.4% of dental hygienists question their patients about their HbA1c/glycated hemoglobin level if the patient has diabetes (Table III). There were no significant differences between dentists and hygienists with respect to general risk identification ( $p < 0.281$ ) and diabetes specific risk identification ( $p = 0.216$ ).

Table I: Years of Experience in Clinical Practice

Years Experience	General Dentists (n=106)	Dental Hygienists (n=165)
<1 year	1.0%	0.6%
1-5 years	7.8%	22.7%
6-10 years	13.7%	13.6%
11-19 years	15.7%	21.4%
>20 years	60.8%	40.9%

Table II: Journals read per week

Journals Read	General Dentist (n=106)	Dental Hygienist (n=165)
0	7.8%	15.6%
1	26.5%	53.2%
2-3	47.1%	25.3%
4-5	3.9%	0.6%
>6	14.7%	4.5%

Table III: Risk Identification

Questions 1 through 5: Percentages of respondents who answered "yes" to identification questions for new patients. This includes general and specific risk identification questions.		
Question 6: Frequency percentages of medical history updates.		
Question	DDS	Hygienists
1. Do you have diabetes	89.2%	89.0%
2. Do you have a family history of diabetes	56.9%	35.7%
3. Under physician's care	90.2%	90.9%
4. Are you taking medication	91.2%	92.9%
5. Current HbA1C (Glycated hemoglobin level) (Specific risk identification)	10.8%	8.4%
6. Frequency of Med HX Update		
Never/Rarely	0.0%	1.9%
Sometimes	13.7%	20.8%
Very Often	51.0%	37.7%
Always	35.3%	39.6

In relation to querying patients regarding regimens used to control blood glucose levels (i.e. how often do you ask your patients about the following regimens to control blood glucose) the following categories were presented: diet control, insulin control, self monitor glucose, medication control and patients' perceived level of glycemic

control. Never, rarely, sometimes, very often and always were the response choices, and the correct response was "always." Survey results revealed that 38.2% of respondents always ask about diet control, 44.5% always ask about insulin control and 46.6% always

ask about medication control. Only 17.6% (very often) and 15.5% (always) question their patients regarding their perceived level of glycemic/HbA1c control. The remaining respondents (never (23.4%), rarely (21.6%) or sometimes (21.9%)) questioned the patient about their perceived level of glycemic control. No significant difference in response was noted between dentists and hygienists regarding assessment of glycemic control.

Utilizing factor analysis, survey items were organized and 3 sub-categories emerged: communication, medical/dental management and chair-side testing. Sub-scale scores were computed by taking a mean of responses or associated items. Communication sub-scale consisted of discussing the following: post-operative medications and/or infection control, how well controlled their diabetes is, oral implications of diabetes and how gingival/periodontal treatment may affect glycemic control. The medical/dental management sub-scale consisted of the following: attain medical consults with the patient's physician and modify the frequency of dental visits. The chair-side testing sub-scale consisted of a single item, use in office glucometer. Never, rarely, sometimes, very often and always were the response choices, and the correct response was "always." There was no significant difference between dentists and dental hygienists for the medical/dental management, communication and chair-side testing sub-scales. Dental hygienists were slightly higher than dentists in regards to chair-side testing. Less than half of all respondents (37.8 to 45.3%) reported that they sometimes or very often did all of the above (communication, medical/dental management and chair-side testing), with the exception of chair-side testing. A majority (84.9%) stated they never engaged in chair-side testing, with only 3 respondents (1%) stating that they always use an in office glucometer.

The 4 survey questions regarding self-assessed knowledge are presented in Table IV. Answer responses were strongly disagree, disagree, neither agree or disagree, agree and strongly agree.

Table IV: Self-Assessed Knowledge

	Perio Abscess <sup>a</sup>	Glycemic <sup>b</sup>	Recognizing <sup>c</sup> 8%	Level <sup>d</sup>
Frequency/percent with correct answer	180 (65%)	228 (82%)	179 (64%)	52 (0.19%)

a Periodontal abscesses may be an indication of a patient with uncontrolled diabetes.

b Untreated periodontitis contributes to poor glycemic control.

c Recognizing uncontrolled diabetes is difficult because they respond to periodontal therapy similarly to non-diabetics.

d A patient reporting a glycated hemoglobin level of 8% is indicative of good glycemic control.

1. Periodontal abscesses may be an indicator of a patient with uncontrolled diabetes (correct response: strongly agree)
2. Untreated periodontitis contributes to poor glycemic control (correct response: strongly agree)
3. Recognizing uncontrolled diabetes is difficult because they respond to periodontal therapy similarly to non-diabetics (correct response: strongly disagree)
4. A patient reporting a glycated hemoglobin level of 8% is indicative of good glycemic control (correct response: strongly disagree)

While both groups scored very low in recognizing an 8% HbA1c (glycated hemoglobin) level as an indicator of poor glycemic control, dental hygienists scored slightly better than dentists. In comparison of scores for items related to knowledge of diabetes and periodontal disease, the difference between dentists and dental hygienists was not significant ( $p=0.131$ ). Most respondents (dentists and dental hygienists) agreed or strongly agreed (44.2 and 39.5%, respectively) that untreated periodontal disease contributes to poor glycemic control, while only 44% agreed and 22.5% strongly agreed that periodontal abscesses may be an indication of a patient with uncontrolled diabetes. Table IV displays the results of the self assessed knowledge items. Table answers were dichotomously grouped (0=incorrect response and 1=correct response).

A majority of all respondents (dentists and dental hygienists combined) stated they were very confident (17%) or confident (62.5%) in managing the diabetic patient in the office (Table V). When questioned about preventing in-office emergencies, 18% were not confident, 63% stated they were confident and 19% stated that they were very confident. The majority of all respondents (50.5%) responded that they are not very confident in screening patients for diabetes by using an in office glucometer.

A "professional norms" variable was created by



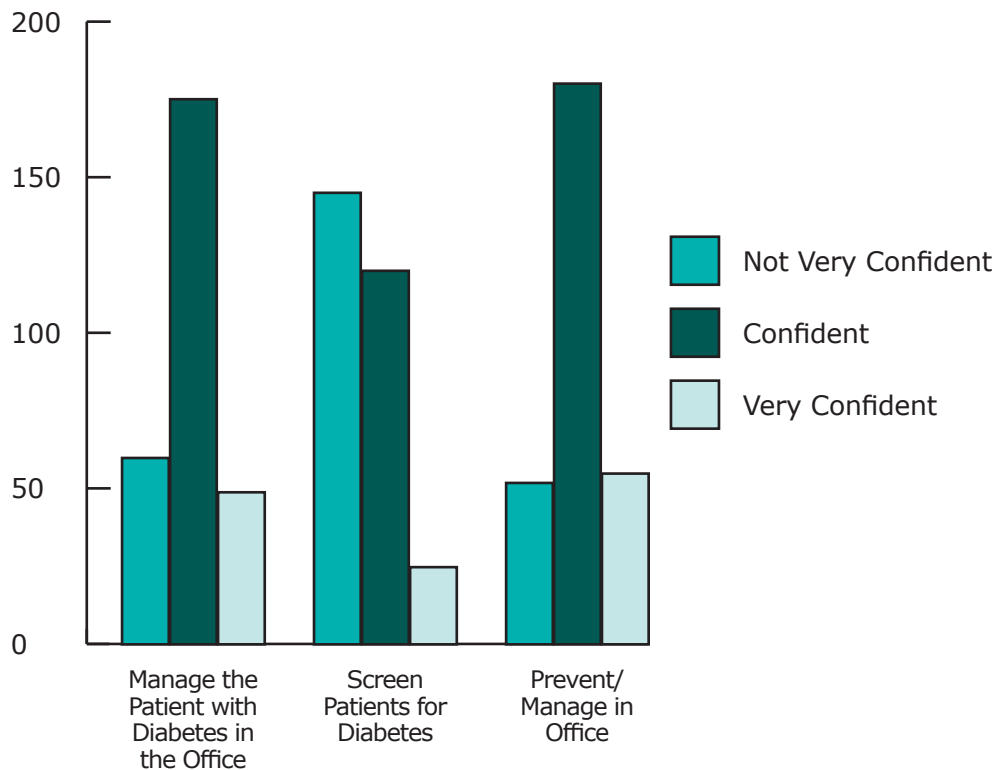
those responding positively to the following: my patients expect, my employer/employees expect and/or my colleagues expect me to take a more active role in diabetes management. A professional norms sub-scale score was computed by taking a mean of these 5 items. Logistic regression was used to model best practice outcome as a function of knowledge, professional/social norms or training.

In regards to professional norms (i.e. "what others expect me to do"), Likert style questions extracted the respondents' strength of professional responsibility regarding diabetes management. Answer responses were: strongly disagree, disagree, neither agree or disagree, agree and strongly agree. The preferred response for all statements was strongly agree, with the exception of "taking a more active role in diabetes management is too time consuming." For this statement, the preferred response was strongly disagree. The distribution of responses is displayed in Table VI. The responses were varied with the exception of "I feel competent taking a more active role in diabetes management." For this item, 48.8% of respondents agreed. No other items elicited a strong response. The majority of all respondents neither agreed nor disagreed with the following statements: "My patients expect me to take an active role in their diabetes management" (33%) and "My colleagues expect me to take an active role in diabetes management" (37.5%). The highest percentage (39.6%) disagreed with the statement "Taking a more active role in diabetes management is too time-consuming."

Dentists and hygienists responding positively to "My patients expect" and "My employer/employees expect." "My colleagues expect me to take a more active role in diabetes management" was a stronger indicator of pro-active practice behavior in regards to the management of the patient with diabetes. Neither knowledge of diabetes ( $p=0.285$ )

Table V: Self-Assessed Confidence

How confident are you in your ability to:



nor provider type ( $p=0.186$ ) was a strong indicator of practice behavior.

## Discussion

While most respondents of this survey agreed that untreated periodontal disease contributes to poor glycemic control, it is surprising to find that 87.9% of respondents do not question their patients regarding their HbA1c/glycated hemoglobin level and, additionally, 70.7% remained neutral regarding their perceptions of an HbA1c level of 8%, clearly indicative of poor glycemic control. In most labs, the normal HbA1c range is 4 to 5.9%.<sup>25</sup> In addition, the majority of respondents stated they are not very confident in screening patients for diabetes. Monitoring the HbA1c level plays a crucial role in risk management of patients with diabetes. Hyperglycemia, hypoglycemia and/or blood glucose level are familiar terms for most practitioners. The HbA1c level is a newer term/standard used to determine a diabetic patient's level of glucose control. The HbA1c level gives a more accurate measure of the average level of glycemic control and should be collected and documented for a diabetic patient similar to the blood pressure of the hypertensive patient. The HbA1c level not only identifies potential patients at risk for a poor response to periodontal therapy, it is also an important tool for



Table VI: Professional Norms

Percentages for DDS and RDH					
	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
My patients expect me to take an active role in their diabetes management	8.6%	30.5%	33.0%	23.3%	4.7%
I feel competent taking a more active role in diabetes management	4.8%	13.8%	22.8%	48.4%	10.0%
Taking a more active role in diabetes management is too time consuming	13.9%	39.6%	33.3%	10.4%	2.8%
My colleagues expect me to take an active role in diabetes management	4.2%	21.2%	37.5%	28.8%	8.3%
My employer or employees expect me to take an active role in diabetes management	6.9%	23.4%	35.2%	25.9%	8.6%

management of the patient with diabetes in the following areas:

- Medical emergencies
- Recall interval
- Referral to the patient’s physician and/or periodontist
- Possible delay of treatment

Not knowing the HbA1c level or understanding the implications of this value could have a significant impact on the control and management of the diabetic patient’s periodontal condition. In addition, the level of glycemic control can have a significant impact on in-office emergencies. With a lower mean plasma glucose level, the risk for hypo-glycemia and a possible in-office emergency increases. As glycemic control moves closer to the normal range the risk for hypoglycemia increases. The patient with tight control of their glucose levels can drop into the hypoglycemic range quickly. A potential hypoglycemic episode may be influenced by one or all of the following: exercise before the dental appointment, when the patient last took their medication and if they did not eat when they took their medication. The length of the dental appointment may also be cause for concern. Monitoring the mean plasma blood glucose level before and during the appointment is important for the prevention of a hypoglycemic in-office emergency. Oral health care providers’ increased knowledge and better understanding of the HbA1c level as a process of care indicator for the treatment and management of the patient with diabetes and periodontal disease is clearly an area that would benefit diabetic patients, dentists and dental hygienists in Arkansas.

While this study noted a relatively low occurrence of in office chair-side blood glucose testing,

it is worth noting that in order to keep a glucometer in the dental office the practitioner must be in compliance with the Clinical Laboratory Improvement Amendments (CLIA) of 1988 and their subsequent amended provisions. Glucometer testing in the dental office is considered a CLIA-exempt procedure, but the office must register with the government and receive a registration certificate. As a result of this, testing is usually done using the patient’s own glucometer. Information on the CLIA may be found at [www.cms.hhs.gov/clia](http://www.cms.hhs.gov/clia). To what degree compliance with the CLIA influenced practitioners’ decisions regarding glucometer use is not known.

In support of evidence based care, the medical and dental professions must treat the body as a whole, realizing that interdisciplinary referrals may be necessary.<sup>30</sup> Syndemic, as described by Singer, is a new term used for 2 or more linked health problems acting synergistically to contribute to the excess burden of disease in a population.<sup>31</sup> Health care providers taking a syndemic approach will view impaired health as a cluster of chronic diseases resulting from multiple forces that bind the conditions together. The multiple forces that bind these conditions together must be addressed with a transdisciplinary approach that crosses professional boundaries.<sup>30</sup> As recommended by the American Academy of Periodontology Guidelines for the Management of Patient’s With Periodontal Disease, only 3.5% of respondents always modify the frequency of dental visits for their patients with diabetes.<sup>26</sup> Nearly half of respondents (45.3%) sometimes modified the frequency, while 32.2% report they very often modified the frequency of dental visits (for the diabetic patient). The chronic nature of periodontal disease and diabetes, as well as the systemic link supported by research, warrants more frequent dental visits as well as pos-

sible co-management with a periodontist and the patient's physician for the patient with diabetes. Considering these results, one could potentially argue that dentists and hygienists in Arkansas may not be optimally assessing diabetes as a risk factor for periodontal disease and may not be considering the level of glycemic control as a factor in the treatment and management of the diabetic patient. The findings also reflect the results of the Kunzel study with respect to assessment and management of the diabetic or unidentified diabetic patient.<sup>9</sup> Assessing diabetes as a risk factor for periodontal disease and the patient's level of glycemic control is not only critical in patient assessment, health promotion and disease prevention – it impacts treatment planning, maintenance intervals, length of appointments, treatment outcomes and potential in-office emergencies. The attitudes and behaviors of the oral health professional must at a minimum keep pace with the evidence in treatment of patients with diabetes and periodontal disease.

The Theory of Reasoned Action (TRA) and the Theory of Planned Behavior (TPB) both operate under the assumption that the best predictor of a behavior is behavioral intention.<sup>33</sup> Behavioral intention is determined by attitude toward the behavior and social normative perceptions regarding it. The foundation of TRA and TPB is "individual motivational factors are determinants of the likelihood of performing a specific behavior" (perceived control over performance of the behavior is an additional construct of TPB).<sup>33</sup> TRA was developed by Fishbein in an effort to understand the relationship between attitudes and behavior.<sup>33</sup> Both TPB and TRA focus on the constructs of attitude, subjective norm and perceived control, and have been used successfully to predict and explain a wide range of health behaviors and intentions.<sup>33</sup> The respondents practicing the best behavior in regards to diabetes identification and management were incorporating it as being within the scope of their professional norm/standard and had control over the behavior. Motivation to perform the behavior is also linked to what others expect, whether important referent individuals approve or disapprove of performing the behavior, weighted by the motivation to comply with those referents.<sup>33</sup> Attitude is also determined by the individual's belief about the outcomes or attributes of performing the behavior.<sup>33</sup> Those dentists and dental hygienists who hold strong beliefs that positively valued outcomes will result from performing the behavior will have a positive attitude toward the behavior, namely taking a more active role in diabetes management.

Diffusion as defined by Everett Rogers is "the process by which an innovation is communicated

through certain channels over time among the members of a social system."<sup>34</sup> An innovation is an idea, practice or object that is perceived as new by an individual. Adopting/diffusing practice behaviors that incorporate diabetes screening and management can have a positive impact on cost, quality of care and patient health and satisfaction. Health care, dentistry included, is a very dynamic and innovative field and as such is constantly evolving. Dentists and dental hygienists can and should be proactive and play a key role in risk identification and risk management for their patients with diabetes and periodontal disease. In 2008, the ADEA House of Delegates approved The Competencies for the New General Dentist, emphasizing the need for the general dentist to go beyond the traditional practice of focusing only on oral health and being able to practice evidence-based comprehensive dentistry both independently and collaboratively to improve the health of society.<sup>35</sup> These competencies are also supported by the 1995 Institutes of Medicine's Committee on the Future of Dental Education, which emphasized the broadening of knowledge about oral health care problems as they relate to systemic diseases.<sup>23</sup> Casual blood glucose screening and understanding the significance of the HbA1c are clearly areas for improvement for dental and dental hygiene students, as well as all oral health providers.

**Limitations:** The potential limitations of this study are the low response rate and limited demographic area. The validity of these findings must be weighed in light of the disappointingly low response rate. This study was the first to question and compare dentists and hygienists in Arkansas regarding their risk identification and management behavior of patients with diabetes. Future studies are warranted with an increased effort to improve the response rate in order to produce a more powerful study. Despite the low response rate, these findings can be used as a basis to investigate these issues further. Although the study was also limited to oral health practitioners in Arkansas, this study could be utilized in other states or geographic areas to compare the use of diabetic health indicators in the assessment and management of patients with periodontal disease. Results from this study are also useful as evidence to enact change in dental and dental hygiene curricula in regards to risk assessment and risk management for patients with diabetes.

Limitations are inherent in self-reported data, however the socially desirable responses present in these self-reported data has not served to temper the tone of the study's results. This is evidenced by the dentists and dental hygienists relatively low

levels of self-reported patient management behavior in regard to monitoring glycemic control/HbA1c levels, modifying the frequency of dental visits and knowledge of glycated hemoglobin/HbA1c levels.

## Conclusion

Although the evidence supports the need for appropriate risk assessment and risk management for the patient with diabetes and periodontal disease, these initial findings indicate that dentists and dental hygienists in Arkansas inquire and discuss more than they actively undertake measures to control or manage these risk factors. Both groups are more proactive with dental management than medical management of their patients. With an approximate estimate that 5% of all patients seen in dental offices have diabetes, and given the large number of undiagnosed cases, health professionals are in unique position to screen their patients for

diabetes.<sup>22,36,37</sup> Oral health care providers have the potential to influence patients' periodontal health and general health outcomes, and lead the way for other health professionals by taking a syndemic approach.

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## Characteristics of Dental Hygienists based on Holland's Career Choice Theory

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### Introduction

Multiple barriers, such as lack of awareness and adequate assessment instruments, are preventing students from considering dental hygiene as a career choice alternative. Effective recruitment strategies are critical to attract qualified applicants and meet the oral health care needs of the nation. Few studies have been published that examine predictors of career choice for dental hygienists, and even fewer are based on career theory. Prior to conducting theory driven career choice research in dental hygiene, characteristics based on theory constructs of satisfied dental hygienists in various career tracks within dental hygiene need further description. Results of this research can then be utilized to develop improved career assessment instruments and examine career choices of dental hygiene students.

Building from counselor experience and the vocational literature, Holland first constructed the Vocational Preference Inventory in 1958, examining preferences for occupations of 300 college freshmen based on personality traits.<sup>1</sup> This inventory was later validated when compared to the 16 personality factor questionnaire for 763 boys and 394 girls.<sup>2</sup> While this inventory focused on characteristics of the individual, Holland went on to describe environments by examining the distribution of people within the environment. Astin and Holland developed the Environmental Assessment Technique by examining correlations between institutional size, intelligence level and 6 personality characteristics for students who completed the College Characteristics Index at 36 institutions.<sup>3</sup> This assessment technique suggests that environments are dependent or influenced by the typical characteristics of its members.

In 1971, Holland developed a self-scored interest survey (Self-Directed Search) to determine place-

### Abstract

**Purpose:** The purpose of this study was to survey 1,800 current licensed dental hygienists in the U.S. and identify broad and basic interest patterns within Holland's 6 General Occupational Themes.

**Methods:** A national stratified random sample of 1,800 members of the American Dental Hygienists' Association was surveyed. Paper and online surveys included the Strong Interest Inventory and the Skills Confidence Inventory. Descriptive statistics and independent t-tests were used to analyze the data.

**Results:** A total of 928 participants (51.9%) completed and returned the paper survey, while 436 participants (24.4%) also completed the online surveys. Results support coding the dental hygiene profession as Investigative – Social – Realistic using the General Occupational Themes. Dental hygienists had the most significant mean differences in the Healthcare Services, Medical Science and Science Basic Interest Scales as compared to the General Representative Sample.

**Conclusion:** Holland's 6 General Occupational Themes have the potential to help guide student choice regarding dental hygiene as a career.

**Keywords:** Dental hygienist, career assessment, Holland's General Occupational Themes, career theory

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

ment within 6 personality types, including realistic, investigative, artistic, social, enterprising and conventional.<sup>4</sup> In 1975, the Self-Directed Search was validated when compared to the Kuder Preference Record, the Thurstone Temperament Schedule, the Bennett Mechanical Comprehension Test and the Minnesota Paper Form Board using a sample of 158 high school students.<sup>5</sup> Holland's theory relies on the premise that when personality type matches the environment, the person will experience job satisfaction, career stability and work achievement.<sup>1,6</sup>

Holland described the 6 types of personality and the matching 6 environments.<sup>1</sup> The realistic type possesses traditional values within a closed system of beliefs. This person perceives oneself as mechanical, technical and athletic, and may be described as conforming, inflexible, practical, reserved and persis-

tent. The investigative type holds scientific and scholarly values above other life values, and perceives oneself as analytical and curious with broad interests and may be described as complex, critical, independent, intellectual, pessimistic and unassuming. The artistic type values self-expression and equality for all, and perceives oneself as artistic and musically able, and may be described as emotional, expressive, idealistic, imaginative, intuitive and sensitive. The social type values religion, helpfulness and forgiveness, and perceives oneself as understanding, with a lack of scientific ability and may be described as cooperative, friendly, generous, patient, responsible and warm. The enterprising type values economic and political achievement, and perceives oneself as aggressive, popular and self-confident and may be described as adventurous, assertive, extroverted, forceful and sociable. The conventional type values business and economic achievement with traditional conservatism, and perceives oneself as conforming and orderly with little skills in the arts and may be described as careful, dogmatic, efficient, methodical, practical and thorough. Since the characteristics of the environment reflect the typical characteristics of the members, the 6 environment types are parallel to the personality types.

In 1980, Holland developed an instrument to measure vocational identity, the need for occupational information and personal or environmental barriers based on a sample of 496 high school sophomores.<sup>7</sup> "A person with a clear sense of identity is more likely to accept or find work that is congruent with his or her personal characteristics and to persist in his or her search for a congruent work environment."<sup>6</sup> The vocational identity, occupational information and barriers scales were validated with 824 high school and college students and workers.<sup>7</sup>

Strengths of Holland's typology of personality-environment include:

1. Understandable
2. Clear definitions with internally consistent structure
3. Research supported with various samples including children, adolescents, college students and adults
4. Easy to implement in practice<sup>8</sup>

The Self-Directed Search opens career exploration directly to individuals through the use of computers and internet without dependency on a career counselor.

Holland recognizes that his theory lacks inclusion of cognitive constructs, such as developmental issues and processes of change, and has attempted to

strengthen his theory by adding beliefs and strategies in the typology.<sup>6</sup> Despite its limitations, Campbell and Borgen describe Holland's theory and model as the most useful contribution for both the theoretical researcher and applied practitioner.<sup>9</sup> The Strong Interest Inventory incorporated Holland's 6 General Occupational Themes to help explain high and low scores on the Occupational Scales. The purpose of this study is to survey current licensed dental hygienists in the U.S. to identify broad and basic interest patterns within Holland's 6 General Occupational Themes.

## Methods and Materials

The population for this study was dental hygienists in the U.S., with a minimum age of 20 years and 3 plus years of experience in the field. While the exact number of active dental hygienists in the U.S. is unavailable, the Bureau of Labor Statistics reports there were 158,000 dental hygiene jobs in 2004.<sup>10</sup> Individual contact with each of the 50 licensing bureaus in the U.S. revealed that over 160,000 dental hygienists were currently licensed and active in November 2006. The researchers in this study used the in-state and out-state totals provided by 7 different states and found that an average of 20% of dental hygienists hold a license in a state where they do not live. Based on this analysis, the actual number of licensed dental hygienists in the U.S. may be closer to 128,000.

Members of the American Dental Hygienists' Association (ADHA) were chosen for this sample. About 23,000 licensed dental hygienists are members of the ADHA, representing approximately 18% of the population. Utilizing members of ADHA for this study provided a mixture of associate prepared and baccalaureate prepared dental hygienists working in clinical practice and in other settings such as education, corporation, research and public health.

All states that do not have a baccalaureate program were excluded from the study to increase the number of baccalaureate-prepared dental hygienists in the sample. Any state with fewer than 1,250 licensed dental hygienists was excluded from the study to ensure adequate numbers for the sample. Purposive sampling was used to include Minnesota from division 4 as the home state of the researcher. One state was randomly drawn from the remaining 8 divisions established by the United States Census Bureau representing a random, stratified national sample. The 9 states included in this study were Connecticut, Pennsylvania, Illinois, Minnesota, North Carolina, Tennessee, Texas, Colorado and California.

The ADHA member list did not include gender as a descriptor, so the inclusion of all males to obtain

Table I: Sections within 2004 Revised Strong Interest Inventory

Section:	Number of items:	Short-term (2 to 7 mo) test-retest reliability	Long-term (8 to 23 mo) test-retest reliability
Holland's Six GOTs	153	0.84 to 0.89	0.80 to 0.92
30 Basic Interest Scales	139	0.77 to 0.91	0.74 to 0.90
Occupational Scales	-b	0.71 to 0.93 <sup>a</sup>	-b

<sup>a</sup>Reliability based on 2 to 23 months.

<sup>b</sup>Not available.

an adequate number for gender comparison was not possible. However, the researcher did examine the list and include all names generally associated with male gender in an effort to increase the proportion of males in the sample.

After inclusion of males and known members with advanced degrees, ADHA members were randomly selected using a random number generator to comprise 200 members from each state, for a total of 1,800 participants. Campbell described adequate sampling for occupational scale development with samples of 400 preferred, 300 sufficient and 200 as adequate.<sup>11</sup> This sample size exceeds the recommendation of Campbell.

In order to obtain a high response rate considering the lengthy survey, which included the 291 items in the Strong Interest Inventory and 60 items in the Skills Confidence Inventory, the researcher attempted to follow Dillman's tailored design method for mail surveys, including multiple contacts to participants.<sup>12</sup> A postcard with 3 background questions was mailed along with the final contact letter to provide a way for the researcher to examine non-respondents' career satisfaction, educational attainment and primary reason for not participating.

Given that this investigation involves human participants, approval from the University Institutional Review Board for the Protection of Human Subjects in Research was sought and obtained prior to commencing this study.

**Strong Interest Inventory:** The Strong Interest Inventory was first published as the Strong Vocational Interest Blank in 1927.<sup>13</sup> One of the first occupations developed for this instrument was certified public accountants.<sup>14</sup> The 2004 Revised Strong Interest Inventory was used in this research to identify broad (e.g. Realistic, Artistic) and basic (e.g. Education, Healthcare) interest items within Holland's 6 General Occupational Themes of licensed dental hygienists in the U.S. Strengths of this instrument include:

1. Long history as the first formal interest inventory published in 1927

Table II: Demographics of Respondents to Paper Survey

	n	% <sup>a</sup>
Gender	928	100.0
• Female	983	96.6
• Male	31	3.4
• Missing	4	
Sampled States	928	100.0
• California	108	11.7
• Colorado	101	10.9
• Connecticut	95	10.3
• Illinois	99	10.7
• Minnesota	131	14.2
• North Carolina	94	10.2
• Pennsylvania	105	11.4
• Tennessee	81	8.8
• Texas	103	11.2
• Currently reside outside of sampled states	6	0.6
• Missing	5	
Race	928	100.0
• Caucasian	846	91.7
• African American	9	1.0
• Hispanic (all races)	42	4.6
• Asian	13	1.4
• Native American	3	0.3
• Other	10	1.1
• Missing	5	
Age	928	100.0
• 20-29	166	18.0
• 30-39	199	21.6
• 40-49	239	25.9
• 50-59	266	28.8
• 60-65	50	5.4
• 66+	3	0.3
• Missing	5	

<sup>a</sup>Valid percentages reported

2. Grounded firmly in empirical research
3. Practical and theoretical information
4. Based on normative sample, titled the General Representative Sample (GRS), that is representative of both genders and racial/ethnic diversity found in the U.S.<sup>15</sup>

Participants rank their preferences using a 5 point Likert scale for 293 items "made up of words or short phrases describing occupations, subject areas, activities, leisure activities, people and personal characteristics."<sup>15</sup> The Revised Strong Interest Inventory has 4 main sections:

1. General Occupational Themes
2. Basic Interest Scales
3. Occupational Scales
4. Personal Style Scales

Table I contains summary information about the sections of this instrument. The Personal Style Scales were not used in this study. Multiple studies have reported adequate validity and reliability of the General Occupational Themes when compared to alternate inventories.<sup>15-19</sup> Multiple studies have also reported adequate validity and reliability of the Basic Interest Scales when used to distinguish occupations.<sup>15,20-22</sup>

**Participants:** One thousand eight hundred dental hygienists in 9 different states who were members of the ADHA were mailed information to participate in this research. Thirteen participants were unreachable due to incorrect mailing addresses. A total of 928 participants completed and returned the paper survey, resulting in a 51.9% response rate for the paper surveys. In addition to returning the paper survey, 436 participants also completed the online surveys, resulting in a 24.4% response rate for both the paper and online surveys. Table II contains the demographic characteristics of the 928 dental hygienists who responded to the paper survey. The average participant was female, Caucasian, age 50 to 59 and approximately equally dispersed among the 9 sampled states.

**Non-respondents:** Postcards, with 3 questions, were sent to the 859 non-respondents with 199 returns (23.2%). The first question asked non-respondents to indicate the primary reason for not participating in the study. Seventy-eight percent of non-respondents who completed the postcard did not participate in the research due to time, while the remaining listed no computer/internet (9.5%), not working as dental hygienist (7.5%), unable to log on (0.5%), health reasons (0.5%) and unlisted (4.5%).

The second question on the non-respondent postcard asked non-respondents to indicate all degrees earned at a post-secondary institution. The majority of non-respondents had earned an associate degree or certificate in dental hygiene, 48% had earned a bachelor degree and 11.2% had earned a master or doctoral degree.

Mann-Whitney tests were used to compare levels of degree attainment among respondents and non-respondents (postcards only). Participants who completed the paper and online surveys had earned significantly higher degrees than non-respondents ( $p=0.001$ ). Participants who completed the paper and online surveys had also earned significantly higher degrees than participants who completed only the paper survey ( $p=0.002$ ).

The final question on the non-respondent postcard asked "If you were to choose a career today, would you choose dental hygiene?" This question was utilized to measure global satisfaction with dental hygiene as a career choice. Potential answers included definitely no, probably no, probably yes and definitely yes. In each of the groups, about 84% indicated they would probably or definitely choose dental hygiene today. Mann-Whitney tests were utilized to compare global satisfaction of career choice among respondents and non-respondents. Results contained in Table III indicate that no significant differences were found between any of the groups.

## Results

Results of this study have the potential to positively impact the recruitment and advising of students regarding career track choice and satisfaction within dental hygiene.

**Broad Interest Patterns of Dental Hygienists Compared to GRS and Dentists:** This research compared a national sample of dental hygienists to the GRS used as the reference group for the Strong Interest Inventory. Independent t-tests revealed that dental hygienists had significantly higher mean scores in the Realistic, Investigative, Artistic and Social General Occupational Themes as compared to the GRS. Dental hygienists scored the greatest difference from the GRS in the Investigative theme ( $t=11.93$ ), followed by the Social theme ( $t=8.08$ ) and the Realistic theme ( $t=7.69$ ). These results support coding the dental hygiene profession as Investigative-Social-Realistic (Table IV). The mean differences of dental hygienists working in public health or working as a clinician, educator or manager were also examined. Specific to career settings, dental hygiene clinicians may score higher in the Investigative theme, as compared to dental hygienists in other settings. Dental hygiene managers may score higher in the Enterprising theme, as compared to dental hygienists in other settings.

The researcher was unable to identify any published research describing the broad interest patterns of dental hygienists within Holland's General Occupational themes using the 2004 Strong Interest Inventory. The 1993 version of the Strong Interest



Table III: Mann–Whitney Tests of Career Choice Today by Group

	Mean Rank	Mann–Whitney U	Z	Sig. (2 tailed)
Paper Survey Only	463.73			
Paper & Online	457.93	104348.5	-3.59	0.719
Paper Survey Only	340.73			
Non-respondents (Postcard Only)	332.76	44937.5	-.518	0.605
Paper & Online	313.03			
Non-respondents (Postcard Only)	309.63	40565.0	-.236	0.814

Table IV: Comparison of General Occupational Theme Mean Scores between Women in General Representative Sample (GRS) and Satisfied Women Working in a Dental Hygiene Field (DHYG)

Theme	DHYG		GRS		df	t	p
	$\bar{X}$	SD	$\bar{X}$	SD			
Realistic	49.04	8.19	44.97	8.42	1,445	7.69***	<.001
Investigative	55.88	8.10	48.56	10.12	1,445	11.93***	<.001
Artistic	52.96	9.31	51.31	10.19	1,445	2.61**	0.009
Social	56.93	9.23	51.94	9.92	1,445	8.08***	<.001
Enterprising	49.74	9.49	49.61	9.81	1,445	0.21	0.833
Conventional	49.84	10.12	49.43	10.63	1,445	0.21	0.833

\*\*p<0.01

\*\*\*p<0.001

Inventory published the General Occupational Theme mean scores of female dental hygienists and determined their highest area of broad interest to be Enterprising, with Investigative and Social as supporting themes. This researcher found that dental hygienists had the lowest mean score differences from the GRS in the Enterprising and Conventional themes.

Two previous studies examined the broad interest levels of dentists. Emling et al surveyed 124 freshman dental students along with 104 fellows using the Strong–Campbell Interest Inventory.<sup>23</sup> This older edition of the Strong Interest Inventory used 325 items to examine responses in 3 major categories: General Occupational Themes, Basic Interest Scales and the Occupational Scales. While specific items have changed slightly with the newer version of the Inventory, the General Occupational Theme scores are still composed of the same 6 themes based on Holland’s theory, and are normed to a mean of 50 and a standard deviation of 10. Both dental students and fellows scored the highest mean scores in the Realistic and Investigative themes. While dental hygienists also scored high in the Investigative theme, dentists may differ from dental hygienists in both the Realistic and Social themes (Table V).

Emling et al examined the broad interests of 86 senior dental students using the same version of the Strong–Campbell Interest Inventory.<sup>24</sup> Similar to the

findings of earlier research, male dental students were found to have the highest mean scores in the Realistic and Investigative themes, while female dental students were found to have the highest scores in the Artistic and Investigative themes.

The 1993 version of the Strong Interest Inventory published the General Occupational Theme mean scores of female dentists and determined their highest area of broad interest to be Investigative, with Realistic and Artistic as supporting themes. These areas of broad interest match well with the findings of Emling et al.<sup>24</sup> The 1993 version of the Strong Interest Inventory also assigned broad interest areas to male dentists to be Investigative–Realistic, similar to the findings of Emling et al.

The 2004 Revised Strong Interest Inventory separates interest scores according to gender. Since dental hygiene is predominantly populated with females, comparing female dentist interests to female dental hygienists may be better matched. While both female dentists and dental hygienists scored high in the Investigative theme, female dentists scored higher in the Artistic theme, while female dental hygienists scored higher in the Social theme.

**Basic Interest Patterns of Dental Hygienists Compared to GRS and Dentists:** This research compared a national sample of dental hygienists to



Table V: Comparison of Basic Interest Scales' Mean Scores between Women in General Representative Sample (GRS) and Satisfied Women Working in a Dental Hygiene Field (DHYG)

Theme	GRS		DHYG		t	p
	$\bar{X}$	SD	$\bar{X}$	SD		
<b>Realistic BIS</b>						
• Mechanics & Construction	45.47	8.46	48.65	8.59	5.55**	<0.0001
• Computers & Electronics	46.42	9.22	45.53	8.31	1.56	0.1189
• Military	46.11	8.25	47.84	7.84	3.35***	0.0008
• Protective Services	49.29	9.56	49.78	8.93	0.82	0.4108
• Nature & Agriculture	48.32	10.37	54.69	9.19	9.96***	<0.0001
• Athletics	47.12	9.09	51.43	8.84	7.55***	<0.0001
<b>Investigative BIS</b>						
• Science	47.95	9.93	55.08	8.31	11.76***	<0.0001
• Research	48.40	10.15	51.06	9.69	4.19***	<0.0001
• Medical Science	49.71	10.39	62.28	8.39	19.93***	<0.0001
• Mathematics	47.77	9.84	48.39	9.41	1.01	0.3140
<b>Artistic BIS</b>						
• Visual Arts & Design	50.74	10.37	52.17	9.32	2.23*	0.0259
• Performing Arts	51.82	10.01	54.64	8.97	4.56***	<0.0001
• Writing & Mass Communication	50.79	10.39	50.17	9.71	0.96	0.3384
• Culinary Arts	51.57	9.69	55.79	8.69	7.05***	<0.0001
<b>Social BIS</b>						
• Counseling & Helping	52.29	9.88	55.91	8.69	5.95***	<0.0001
• Teaching & Education	50.81	10.32	55.71	9.72	7.61***	<0.0001
• Human Res. & Training	50.57	10.36	52.39	8.79	2.87**	0.0042
• Social Sciences	50.42	10.24	51.18	8.93	1.21	0.2277
• Religion & Spirituality	50.23	9.79	55.20	9.36	8.11***	<0.0001
• Health Care Services	51.18	10.73	64.15	8.21	20.07***	<0.0001
<b>Enterprising BIS</b>						
• Marketing & Advertising	51.03	10.13	49.92	9.10	1.77	0.0766
• Sales	48.82	9.29	51.45	9.58	4.45***	<0.0001
• Management	48.93	9.88	49.17	9.38	0.39	0.6976
• Entrepreneurship	48.94	10.05	46.09	10.10	4.48***	<0.0001
• Politics & Public Speaking	47.42	9.57	46.33	9.02	1.82	0.0682
• Law	49.51	10.06	48.36	10.10	1.81	0.0710
<b>Conventional BIS</b>						
• Office Management	52.27	10.77	52.53	9.12	0.39	0.6932
• Taxes & Accounting	48.93	10.51	49.06	10.26	0.20	0.8441
• Program & Info. Systems	48.14	10.35	45.22	9.31	4.56***	<0.0001
• Finance & Investing	47.53	9.34	48.10	8.51	0.98	0.3251

\*p<0.05

\*\*p<0.01

\*\*\*p<0.001

the GRS used as the reference group for the Strong Interest Inventory. Independent t-tests revealed that dental hygienists had significantly higher mean scores in 16 of the 30 Basic Interest Scales as compared to the GRS. The most significant mean differences were in the Healthcare Services, Medical Science, Science, Nature and Agriculture, Religion and Spirituality, Teaching and Education and Athletics Basic Interest Scales (Table VI).

The Basic Interest Scale mean differences of dental hygienists working as a clinician, educator, manager and working in public health were also examined (Table VII). Specific to career settings, public health workers scored higher within the Research, Counseling and Helping and Social Sciences Basic Interest Scales. Educators scored higher in the Research, Performing Arts, Counseling and Helping and Teaching and Education Basic Interest Scales.

Managers scored higher in the Human Resource and Training, Marketing and Advertising, Management, Entrepreneurship and Office Management Basic Interest Scales. Dental hygiene clinicians scored higher in the Medical Science and Healthcare Services Basic Interest Scales.

Gasser et al examined the concurrent validity of the 2005 Strong Interest Inventory based on a national college sample of 1,403 women.<sup>25</sup> Cross-validation of findings was completed on a sample of 469 males. Discriminant analyses were completed to examine the ability of the General Occupational Themes to predict college major as compared to the Basic Interest Scales. Using 31 college majors as the criterion variable, Gasser et al found that the General Occupational Themes alone accurately classified 15.5% of the majors and the Basic Interest Scales alone accurately classified 33.7% of the majors, as compared to chance (3.2%). The current research supports the findings of Gasser et al in that the Basic Interest Scales may be the most effective at distinguishing career interests in dental hygiene, by setting.

This researcher was unable to identify any published research describing the basic interest patterns of dental hygienists within Holland's General Occupational themes using the 2004 Strong Interest Inventory. The 1993 version of the Strong Interest Inventory did not publish the Basic Interest Scale mean scores of female dental hygienists.

Two previous studies examined the basic interest levels of dentists. Emling et al surveyed 124 freshman dental students along with 104 fellows using the Strong-Campbell Interest Inventory.<sup>23</sup> This older edition of the Strong Interest Inventory used 325 items to examine responses in 3 major categories: General Occupational Themes, Basic Interest Scales and the Occupational Scales. Unfortunately, the basic interest scales in the Strong Interest Inventory have changed and so limit comparisons. However, the Basic Interest Scales were still normed to a mean of 50 and a standard deviation of 10. Dental students scored the highest mean scores in the Medical Science, Medical Service, Mechanical Activities and Athletics Basic Interest Scales. Dental fellows scored the highest mean scores in Medical Science, Military Activities, Mechanical Activities and Science Basic Interest Scales. While dental hygienists also scored high in the Medical Science and Healthcare Services Basic Interest Scales, it appears they may differ in other scales. However, only 25 female dental students were part of the 1980 study, and it is probable that gender differences were demonstrated in the Basic Interest Scales.

Emling et al examined the broad interests of 86

senior dental students using the same version of the Strong-Campbell Interest Inventory.<sup>24</sup> Since dental hygiene is predominantly populated with females, comparing female dentist interests to female dental hygienists may be of more value. Female dental students were found to have the highest mean scores in the Medical Science, Music, Art, Domestic Arts and Nature Basic Interest Scales. While both female dentists and dental hygienists scored high in the Medical Science and Nature Basic Interest Scales, they appear to differ in the Arts.

**Dental Hygiene Occupational Scale:** Currently, 122 occupations for both males and females are represented in the 2004 Revised Strong Interest Inventory. However, dental hygiene has not been developed. According to protocol defined within the Revised Strong Interest Manual, items with a 16% or greater difference between the criterion group and the same-gender GRS were used as the starting point for inclusion within the dental hygiene occupational scale.<sup>13</sup> Specific Occupational Scale item responses from the GRS are needed for comparison in order to construct an Occupational Scale for dental hygienists. The researchers were unable to review this specific Occupational Scale data from the GRS, but CPP (formerly Consulting Psychologists Press) was willing to construct the dental hygiene Occupational Scale for this study. The female dental hygiene scale for the 2004 Strong Interest Inventory was developed from the sample collected by the researcher (n=322) with 30 items, with a minimum percent difference of 25%, and a Q of 1.68. Insufficient numbers of male dental hygienists prevented construction of an occupational scale for male dental hygienists.

On average, the Occupational Scales in the Strong Interest Inventory differ from the comparison sample (GRS) by about 1.5 standard deviations. For the female dental hygienists Occupational Scale, the occupational sample differs from the comparison sample (GRS) by about 1.7 standard deviations on average. This suggests that the dental hygiene occupational scale is more tightly defined and distinct from other occupations, resulting in higher validity, as compared to the average occupational sample within the Strong Interest Inventory.<sup>13</sup> A sample of the 30 discriminating items selected for dental hygienists included the following: biologist, dental assistant, dentist, determining the cause of a disease and giving first aid assistance.

Female dental hygienists in this sample had mean scores most similar to pharmacists, registered nurses, respiratory therapists, radiologic technicians, dietitians, recreation therapists, chiropractors, nursing home administrators and dentists. Paired sample t-tests were used to compare the dental hygien-

ists' mean scores between the dental hygiene Occupational Scale and the 9 most similar Occupational Scales. Significant differences were found between the dental hygiene Occupational Scale and all 9 similar Occupational Scales. Examining the t values, dental hygienists were the most similar to respiratory therapists ( $t=-3.82$ ) and radiologic technologists ( $t=-4.79$ ). Of the 9 similar Occupational Scales, dental hygienists were the least similar to chiropractors ( $t=-17.82$ ) and dentists ( $t=-17.83$ ).

## Conclusion

This research suggests that female dental hygienists should be coded as Investigative–Social–Realistic using the General Occupational Themes. The General Occupational Themes demonstrate some potential in ability to distinguish the broad interests of dentists and dental hygienists. Using the Basic Interest Scales from the Strong Interest Inventory dental hygienists scored the highest in the areas of Healthcare Services, Medical Science and Science. In particular, individuals who score high on the Health Services Basic Interest Scale may want to consider dental hygiene as a potential career choice. The ability to distinguish dental hygienists from dentists with Basic Interest Scale mean scores is limited, influenced by the lack

of current research. If an assessment measure specific to dental hygiene is developed, researchers may want to examine the applicability of items from those Basic Interest Scales to help determine similar interests.

Career assessment instruments such as the Strong Interest Inventory could also be utilized by education institutions during summer orientations or freshman orientation courses to identify students' career interests. In addition, departments or colleges could develop and implement introductory courses designed to increase awareness about the careers available in that unit, while emphasizing assessment of person–fit to environment with career assessment instruments. Opportunity for secondary students to attend an introductory course may enable earlier assessment of career fit and promote obtainment of degree within 4 years. Currently, the program requirements for a baccalaureate degree may not afford college students with much opportunity for career exploration, to assure completion within 4 years.

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## A Comparison of Dental Ultrasonic Technologies on Subgingival Calculus Removal: A Pilot Study

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### Introduction

More than 80% of the adult population has some form of periodontal disease. In fact, 90% of the 55 to 64 age group has moderate periodontal disease.<sup>1</sup> To date, there are a number of different treatment modalities in the treatment and prevention of periodontal diseases. Conventional treatment for the removal of calculus and plaque biofilm from the root surfaces includes the use of hand-activated instruments such as files, curettes and sickles.<sup>2-4</sup> In the early 1990s, a paradigm shift occurred and ultrasonic instrumentation was the first choice in periodontal instrumentation and became a standard and accepted therapeutic modality.<sup>5-9</sup> There are limited in vivo studies that compare the clinical and therapeutic outcomes of ultrasonic and hand-activated instrumentation, as well as the effects on root surfaces.<sup>2,10-12</sup> However, there is no literature that directly compares the clinical endpoint (immediately post therapy), such as the removal of plaque biofilm, calculus and endotoxin on the root surfaces as well as the root surface characteristics of the magnetostrictive and piezoelectric ultrasonic technologies. As a result, dental health professionals often discuss the differences between the 2 ultrasonic technologies and surmise that one ultrasonic technology is more effective than the other. Some practicing clinicians understand that each instrument works somewhat differently and, thus, these differences may account for anticipated dissimilarities in clinical and therapeutic outcomes. However, these discussions and claims seem to be anecdotal in nature.

### Abstract

**Purpose:** This pilot study compared the clinical endpoints of the magnetostrictive and piezoelectric ultrasonic instruments on calculus removal. The null hypothesis stated that there is no statistically significant difference in calculus removal between the 2 instruments.

**Methods:** A quasi-experimental pre- and post-test design was used. Eighteen participants were included. The magnetostrictive and piezoelectric ultrasonic instruments were used in 2 assigned contra-lateral quadrants on each participant. A data collector, blind to treatment assignment, assessed the calculus on 6 predetermined tooth sites before and after ultrasonic instrumentation. Calculus size was evaluated using ordinal measurements on a 4 point scale (0, 1, 2, 3). Subjects were required to have size 2 or 3 calculus deposit on the 6 predetermined sites. One clinician instrumented the pre-assigned quadrants. A maximum time of 20 minutes of instrumentation was allowed with each technology. Immediately after instrumentation, the data collector then conducted the post-test calculus evaluation.

**Results:** The repeated analysis of variance (ANOVA) was used to analyze the pre- and post-test calculus data ( $p \leq 0.05$ ). The null hypothesis was accepted indicating that there is no statistically significant difference in calculus removal when comparing technologies ( $p \leq 0.05$ ). Therefore, under similar conditions, both technologies removed the same amount of calculus.

**Conclusion:** This research design could be used as a foundation for continued research in this field. Future studies include implementing this study design with a larger sample size and/or modifying the study design to include multiple clinicians who are data collectors. Also, deposit removal with periodontal maintenance patients could be explored.


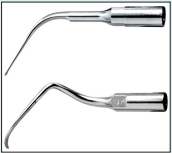

**Keywords:** Ultrasonic instrumentation, calculus removal, piezoelectric, magnetostrictive

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

There are 2 methods of ultrasonic instrumentation: magnetostrictive and piezoelectric technologies. Each technology has similarities and differences, especially in relation to tip adaptation.



Table I: A Comparison of Ultrasonic Dental Units

Type of Unit	Mechanism of Action	Frequency Cycles/second	Motion of Tip	Tip Samples
Magnetostrictive	Change in electromagnetic field in the ferromagnetic rod causes rapid vibrations	25,000 to 42,000 Hz	Elliptical or Orbital	 <p>Image courtesy of Dentsply</p>
Piezoelectric	Alternating electrical currents applied to the crystal transducer creates a dimensional change that causes rapid vibrations	25,000 to 50,000 Hz	Linear	 <p>Image courtesy of Hu-Friedy Mfg. Co., Inc.</p>
Sonic Instrument	Vibrations are generated by air-turbine from dental unit.	3,000 to 8,000 Hz	Elliptical or Orbital	 <p>Image courtesy of DentalEz</p>

The piezoelectric technology works by adapting 1 of the 2 sides of the tip, whereas any side of the magnetostrictive insert (tip) can be adapted. The piezoelectric tip moves in a linear fashion and the magnetostrictive moves in an elliptical motion (Table I). These differences raise the question of whether tip motion and adaptation would effect calculus removal. The literature reveals that hand-activated, sonic, magnetostrictive and piezoelectric instrumentation provide similar therapeutic results over time as evaluated by measuring bleeding, probing depth, calculus and endotoxin removal.<sup>4</sup>

To date, there is no literature that directly compares the clinical endpoint (e.g. removal of plaque biofilm, calculus and endotoxin from root surfaces) when using the magnetostrictive and piezoelectric ultrasonic instruments. A review of the literature found in vitro studies that compared the 2 technologies using extracted teeth.<sup>3,13,14</sup> In vivo studies that specifically compare both methods of ultrasonic instrumentation are nonexistent. Therefore, clinical evidence is lacking which may lead to the assumption by oral health clinicians that one technology is more effective than the other. If one technology was to be more effective in removing plaque biofilm and calculus, is it possible then that

the technology that removes more deposits could result in improved therapeutic outcomes? Therefore, the null hypothesis for this study stated that there is no statistically significant difference in calculus removal between the 2 ultrasonic technologies.

### Review of the Literature

Conventional methods for the treatment of periodontal disease include sonic, ultrasonic and hand-activated instrumentation.<sup>4</sup> In the treatment of periodontal diseases, different methods of instrumentation are implemented for maximum healing and restoration of periodontal health. Methods include debridement, scaling and/or root planing and the addition of antibiotics delivered locally or systemically.<sup>15-17</sup> Research studies have investigated the use of ultrasonic and hand-activated instrumentation for the removal of deposits to restore periodontal health.<sup>10,14,18-21</sup>

Ultrasonic instruments were first introduced in dentistry in the early 1950s for the purpose of cutting teeth.<sup>22</sup> In the 1960s, McCall et al reported ultrasonic instrumentation as an acceptable method for plaque biofilm and calculus removal.<sup>23</sup> The main objective for the dental hygiene clinician is to prepare the root surface and promote healing

over time as evaluated by therapeutic outcomes during non-surgical periodontal therapy and periodontal maintenance procedures.<sup>13</sup>

**Mechanism of Action:** Lea et al conducted a study evaluating the Dentsply Cavitron (Dentsply International, York, PA) (a magnetostrictive ultrasonic) and the EMS piezoelectric scaler.<sup>24</sup> The TFI-3 and TFI-10 (Through Flow Insert) ultrasonic tips were used with the cavitron, and the P-10 tip for the piezoelectric. The authors concluded that all generators and tips exhibited differences in amplitude (tip movement). The dental hygiene clinician must understand that although ultrasonic instruments are somewhat similar in operation, they are not exactly equal in relation to power and frequency, and the main difference between the 2 technologies is the working sides of the tips.

The frequency, or speed, refers to the number of times the tip completes an elliptical or linear cycle per second. A frequency of 35,000 Hz (35 kHz) equates to movement of the tip 35,000 cycles in 1 second. The amplitude, or power, controls the length of the stroke of the tip but maintains the same frequency. The higher the power, the longer the stroke and the more powerful the impact on the calculus.<sup>25</sup> In fact, clinical power is the ability to remove deposits in relation to the stroke, frequency, type of motion (elliptical or linear) and the angulation of the tip to the deposit or tooth surface.<sup>25</sup>

The water exiting the tip has been shown to have 3 physiologic effects on the plaque biofilm. Acoustic microstreaming is the flow of water caused by the ultrasonic waves. Acoustic turbulence is created by the rapid movement of the tip resulting in a swirling effect of the water, and cavitation is the formation of bubbles that implode and create additional turbulence.

The piezoelectric ultrasonic dental unit consists of a base (generator), a hand piece that houses a crystal transducer and a foot pedal. The tip is attached to the hand piece with a wrench, and depressing the foot pedal sends an electrical current to the crystal transducer that converts electrical energy to mechanical energy. This results in rapid vibrations that cause the working end of the tip to vibrate in a linear motion. The magnetostrictive ultrasonic instrument consists of a generator, foot pedal, hand piece and a transducer, also known as an insert. The transducer or core is a stack of metal strips or ferromagnetic rod that is attached to the working end or tip. A copper wire coil found in the hand piece produces a magnetic field within the transducer when the foot pedal is depressed

Table II: Suggested Use of Piezoelectric and Magnetostrictive Ultrasonic Instruments (from Flemmig et al)<sup>28</sup>

Piezoelectric		
Tip Angulation	Lateral Pressure	Power Setting
0°	0.5 N to 2 N	Low - Medium
45°	0.5 or 1 N	Low
	0.5 N	Medium
90°	0.5 N	Low
Magnetostrictive		
Tip Angulation	Lateral Pressure	Power Setting
0°	2 N	Low
45°	0.5 N	Low - Medium

and electrical energy is created. The process of magnetizing and demagnetizing causes the core to contract and return to its original shape. This fluctuation in the electromagnetic field causes the tip to vibrate in an elliptical 360° movement (Table I). Unlike the piezoelectric, this elliptical motion allows any portion of the insert to adapt to the tooth surface.<sup>26,27</sup>

A main concern during periodontal instrumentation is the unnecessary removal of the root surface while striving to remove deposits. A study by Flemmig et al analyzed defect depth and defect volume using extracted teeth mounted on resin and instrumented on 1 root surface with the piezoelectric technology.<sup>28</sup> To prevent extensive root substance removal exceeding more than 50 µm per year, the authors recommended any combination of:

- 0° tip angulation, 0.5 N to 2 N lateral force and low to medium power
- 45° tip angulation, 0.5 N or 1 N lateral force and low power setting
- 45° tip angulation, 0.5 N lateral force and medium power setting
- 90° tip angulation, 0.5 N lateral force at a low power setting

A similar study conducted by the same authors using the magnetostrictive ultrasonic instrument reported similar results (Table II).<sup>29</sup>

**Contemporary Ultrasonic Instrumentation in Therapy:** A landmark in vitro study carried out by Busslinger et al compared magnetostrictive, piezoelectric and curets with regard to time taken for instrumentation, calculus removal and root surface roughness.<sup>18</sup> The researchers reported no statistical significant difference in calculus removal

when comparing the 3 treatment modalities. The study also showed that of the 3 instruments used, the magnetostrictive device produced the smoothest root surface. Conversely, Cross-Poline et al also compared the effects of the magnetostrictive and piezoelectric ultrasonic instruments.<sup>30</sup> The authors concluded that the piezoelectric instrument produces a smoother root surface than the magnetostrictive. The literature shows that both instruments produce similar therapeutic outcomes. However, there is conflicting evidence in the area of root surface smoothness with studies showing evidence for both technologies.<sup>18,20,30</sup>

Developments in ultrasonic tips, especially the precision thin inserts (PTIs), make ultrasonic instrumentation more effective towards the apex and furcation areas than hand-activated curets because the shape of the tip allows easy access to the root surface.<sup>31</sup> Many of the tips are thin and are designed for site-specific areas depending on where it is to be used and the amount of hard deposits to be instrumented.<sup>31</sup> A systematic review completed by Tunkel et al compared the effectiveness of subgingival hand-activated scaling and ultrasonic instrumentation, and concluded that debridement by ultrasonics was more effective requiring less time than hand-activated instrumentation and also resulted in a less stressful experience for the patient.<sup>8</sup> Additionally, a survey of clinical evaluations with magnetostrictive and piezoelectric technologies utilized by practicing dental hygienists and reported by the Clinical Research Associates concluded that all 16 ultrasonic instruments tested performed adequately in calculus removal.<sup>32</sup> However, the leading performer in calculus removal was the piezoelectric instrument. Both technologies rated equally in tip access, and the magnetostrictive technology rated higher in patient comfort.<sup>32</sup>

Based on a review of the literature, ultrasonic instruments showed no significant difference in therapeutic outcomes when compared to each other and when compared with hand-activated instruments.<sup>5,33-36</sup> When compared to the magnetostrictive unit, the piezoelectric was found to be more efficient in subgingival calculus removal and provided a smoother root surface.<sup>18,30</sup> Currently, in vivo research directly comparing the effectiveness of the magnetostrictive and piezoelectric is non-existent. Multiple authors report that more research is needed in this area for the purpose of comparing treatment variables such as bleeding on probing, clinical attachment levels, calculus removal, time taken for calculus removal and hypersensitivity.<sup>4,18,37,38</sup> The purpose of this study was to compare the clinical endpoint (calculus removal)

of the magnetostrictive and the piezoelectric technologies. To simulate dental hygiene practice with patients, the present study was conducted as an in vivo research study.

## Methods and Materials

This research study employed a quantitative quasi-experimental randomized split-mouth design using contra-lateral quadrants. A pre- and post-test design for calculus evaluation was used. Participants exhibited light to moderate amounts of non-tenacious subgingival calculus on buccal, mesial, distal and lingual surfaces of selected test teeth and surfaces. Calculus on root surfaces was measured using the Suter 2R/2L design explorer.

Prior to conducting the clinical study, approval was obtained from the Idaho State University Human Subjects Committee. The committee approved the study under the provisions of Federal Regulations 45 CFR 46. All participants in the study signed and provided informed consent. The principal investigator followed a strict protocol regarding the ethical and confidentiality rights of the participants. All data collection forms were confidential, randomly coded and anonymous to everyone except the researcher.

New and existing patients of a dental hygiene clinic were contacted by phone for this clinical study. Eighteen adults met the inclusion criteria that included the need for initial periodontal therapy, an age range between 18 and 65, moderate non-tenacious subgingival calculus on 6 test sites of contra-lateral quadrants, a minimum of 6 teeth in a selected quadrant and no contraindications to ultrasonic instrumentation. Test sites included a molar (ML and B), premolar (DB and L) and incisor (DL and MB) in contra-lateral quadrants. In the pre-test evaluation, the data collector classified the root surface and presence of calculus using the following scale: 0 (non-existent), 1 (rough), 2 (light) and 3 (moderate). The clinical and teaching experience of the data collector in calculus evaluation contributed in establishing validity and intra-rater reliability. The data was recorded on the dental chart available on the pre-test calculus evaluation form.

The data collector assigned the arch for instrumentation and a coin-flip was used for random treatment assignment of instrument. A stopwatch was used to time 20 minutes for each quadrant of instrumentation. The clinician was blind to the test surfaces and treated the entire quadrant(s) with each instrument. At the completion of instrumentation, the data collector classified the root surface and presence of calculus using the 4 point scale: 0 (non-existent), 1 (rough), 2 (light) and 3 (moderate).

Two newly acquired ultrasonic instruments with new PTIs were set-up side-by-side with easy access from the clinician's sitting position. The straight PTI was inserted or attached to both ultrasonic units for initial instrumentation. The clinician started instrumentation in the anterior, specifically at the central incisor, and moved distally to the canine. The clinician changed tips twice (once for the Right PTI and once for the Left PTI) during the timed instrumentation. In the posterior, the R/L insert was positioned at the distobuccal (DB) or distolingual (DL) line angle and instrumentation was in a buccal/lingual-mesial direction to the midline of the mesial proximal surface. The clinician then adapted R/L tip at the DB/DL line angle and instrumented to the midline of the proximal distal surfaces. The Cavitron Plus® was provided by Dentsply International® and the PTIs used were the universal straight FSI-SLI 10-S for anterior instrumentation, and for posterior scaling the FSI-SLI 10R and the FSI-SLI 10L inserts were used. The Symmetry IQ 3000 series piezoelectric ultrasonic was provided by Hu-Friedy® (Chicago, IL). The 100 Thin Universal S-Series (US 100) (DENTSPLY Professional Division, York, PA) for anterior instrumentation, the Right Perio S-Series (US4R) (Hu-Friedy, Chicago, IL) and the Left Perio S-Series (US4L) were used for posterior instrumentation.

The clinical and teaching experience of the data collector in addition to previous calibration with peers in calculus evaluation contributed in establishing intra-rater reliability. The clinical experience of the clinician contributed in establishing intra-rater reliability of instrumentation. In addition, an experienced dental hygiene educator observed the ultrasonic techniques with both technologies through repeated use of both ultrasonic instruments with the PTIs. The clinician was evaluated on specific criteria developed for subgingival instrumentation with both technologies prior to data collection. Data were analyzed using a pre- and post-test design with an ordinal measurement on a 4 point scale (0, 1, 2, 3). The clinical and teaching experience of the data collector, in addition to previous calibration with peers in calculus evaluation, contributed in establishing intra-rater reliability. One examiner was used. Each of the 6 test surfaces per quadrant was assigned a score and the sum of the 6 surfaces in each quadrant (0 to 18) was used for the analysis of variance (ANOVA) calculation. The ANOVA with repeated measures analyzed the pre- and post-test calculus data ( $p \leq 0.05$ ).

## Results

There were 18 participants in the pilot study (Table III). The majority of the participants were male (62%,  $n=11$ ), between the ages of 18 to 30 years of

Table III: Demographic Variables of the Participants

Characteristics	Participants	Percent
Gender	Female	38% ( $n=7$ )
	Male	62% ( $n=11$ )
Age Range Mean Age: 38	18-30 years	38% ( $n=7$ )
	31-43 years	22% ( $n=4$ )
	44-56 years	33% ( $n=6$ )
	56-65 years	6% ( $n=1$ )
Dental Insurance Coverage	Yes	6% ( $n=1$ )
	No	94% ( $n=17$ )
Physician of Record	Yes	0% ( $n=0$ )
	No	100% ( $n=18$ )
Dentist of Record	Yes	22% ( $n=4$ )
	No	77% ( $n=14$ )

Table IV: ANOVA Within-Subjects Effect: Results of pre-test/post-test calculus evaluation within subjects including tooth surfaces and by technology

Source	df	F	p
Pre-test/Post-test	1	1121.31	0.000
Error (Pre-test/Post-test)	17		
Technology	1	0.05	0.813
Error (Technology)	17		
Pretest/Posttest Technology	1	0.00	1.000
Error (Pre-test/Post-test Technology)	17		

age (38%,  $n=7$ ). Most did have a dentist of record (77%,  $n=14$ ) and all except 1 reported not having dental insurance (94%,  $n=17$ ). All participants reported not having a medical doctor of record (100%,  $n=18$ ).

Table IV illustrates the within-subjects effect of the pre- and post-test calculus evaluation. The main effect for test was significant  $F(1,17)=1121.3$ ,  $p < 0.05$ , but neither the interaction of test by technology  $F(1,17)=.01$ ,  $p > 0.05$  nor the pre- and post-test by technology  $F(1,17)=\emptyset$ ,  $p > 0.05$  were significant.

Table V represents pre- and post-test calculus assessment values for both technologies. The estimated marginal means of the pre- post-test data of calculus assessment for both ultrasonic techniques are reported with a pre-test mean of 17.7 and post-test mean of 4.4. The standard error of the mean is reported as 0.1 for the pre-test and 0.3 for the



post-test.

The data in Table VI represents calculus evaluation for each individual technology by combining the results of the pre- and post-test. Eleven is the estimated mean (0.2 standard deviation) of calculus present for both technologies. Again, both technologies had identical amounts of calculus present at the pre- and post-test evaluations.

Table VII represents the change in calculus data from the pre-test to post-test evaluations. Both technologies reported a pre-test mean of 17.7 and a standard error of 0.1 and the post-test mean of 4.4 and standard error of 0.4. Therefore, ANOVA reveals no statistically significant difference in calculus removal between technologies.

The bar graph in Figure 1 shows the similarities in the results of calculus evaluation for both technologies. The grey bars represent the pre-test mean value of 17.7 and the black bars represent endpoint mean of 4.4. Table VIII shows that there is no statistically significant difference in calculus removal between both ultrasonic technologies (df=1, p=0.8).

## Discussion

The results of this study are in agreement with the literature that measures therapeutic endpoint of both ultrasonic instruments.<sup>3,5,39</sup> One explanation is that the therapeutic endpoint depends heavily on the outcome of the clinical endpoint.

In this study, the operator was permitted 20 minutes for instrumentation in each quadrant. However, if the clinician felt that the root surfaces were smooth as detected with the PTI, instrumentation of that quadrant could cease. The post-test evaluation determined that calculus remained in both quadrants regardless of the technology used and neither technology effectively removed calculus within this 20 minute period. Therefore, this study suggests that more than 20 minutes of instrumentation per quadrant is required for adequate removal of light-moderate subgingival calculus. In addition, it is recommended that ultrasonic instrumentation be followed by hand-activated instrumentation with curets as well as an explorer to assess root surfaces after instrumentation. The appropriate clinical endpoint cannot be reached with ultrasonic instrumentation alone within this timeframe. This practice should also be applied during periodontal maintenance procedures. The results of this study could also suggest that the PTIs do not provide enough tactile sensitivity to render the root surface smooth.

The results of this study are in agreement with an in vitro study conducted by Busslinger et al who

Table V: Estimated Marginal Means Pre-test and Post-test Data

Calculus Assessed	Mean	Standard Error
Pre-test	17.7	0.1
Post-test	4.4	0.3

Note: Specific sites on a molar (ML, B), premolar (DB, L) and incisor (DL, MB) were used to assess outcome of scaling in both quadrants.

Table VI: Estimated Marginal Means of Calculus Score of Both Technologies

Technology	Mean	Standard Error
Magnetostrictive	11.0	0.2
Piezoelectric	11.0	0.2

Table VII: Estimated Marginal Means of Pre-test and Post-test for Each Technology

Pre-test/Post-test	Technology	Mean	Standard Error
Pre-test	Magnetostrictive	17.7	0.1
	Piezoelectric	17.7	0.1
Post-test	Magnetostrictive	4.4	0.4
	Piezoelectric	4.4	0.4

Figure 1: Mean Values for Pre-test and Post-test Calculus Evaluation for Both Technologies

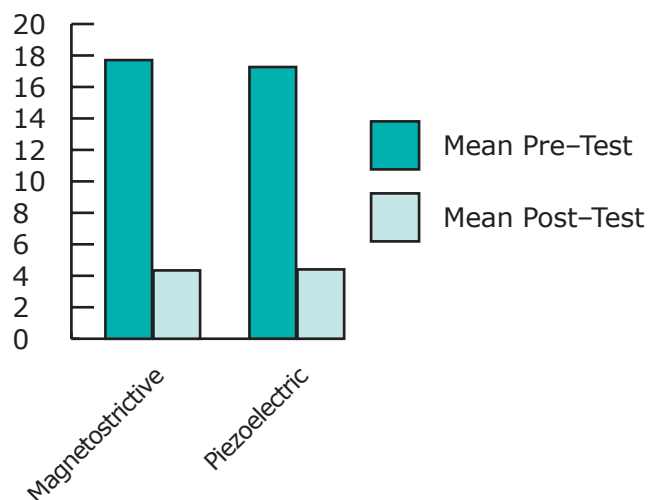


Table VIII: ANOVA Summary Table for Calculus Removal by Ultrasonic Technique

Source	df	F	Type III SS	MS	p
Technologies	1	0.0	0.0	0.0	0.8



reported no difference in calculus removal between the magnetostrictive, piezoelectric and hand instrumentation.<sup>18</sup> In Busslinger's study, instrumentation stopped when the area was "clean and smooth" when examined visually and with an explorer.<sup>18</sup> In the present study, the clinician ceased instrumentation when root surfaces were smooth with the PTI. The authors reported that both ultrasonic instruments removed similar amounts of calculus. The clinician scaled the teeth mounted on stents, which provided much more visual access to root surfaces than any clinician providing instrumentation intra-orally. Even with this accessibility to different areas of the roots, the clinician was still unable to remove all of the calculus on the root surfaces.

Suggestions for future studies include using the same research design to analyze clinical and/or therapeutic outcomes for periodontal maintenance patients. A study conducted by Chapple et al studied the therapeutic outcomes after instrumentation with an ultrasonic unit at full power and at half power, and found that both settings provided similar healing outcomes.<sup>40</sup> Therefore, studies are needed to evaluate ultrasonic scaling with regard to power setting.

## Conclusion

With regard to the hypothesis of this study, the results show that there is no statistically significant difference in calculus removal when comparing the magnetostrictive and piezoelectric ultrasonic technologies. This pilot study has provided information about calculus removal that can encourage dental and dental hygiene educators to incorporate both ultrasonic technologies into the clinical

curriculum. It also provides insight to the dental and dental hygiene student on the differences and similarities of both technologies. It is important to expose dental and dental hygiene students to different technologies available so that they can make an educated decision about what technology they prefer for periodontal therapy.

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