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STATEMENT OF PURPOSE

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.

SUBSCRIPTIONS

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Rebecca Wilder, RDH, BS, MS

Change Can be a Good Thing!

I had a great experience at the recent America Dental education Association meeting in Seattle, Washington. It was wonderful to see dental hygiene colleagues from across the United States and Canada come together to celebrate academic dentistry and dental hygiene. I also had an opportunity to partner with a dental colleague of mine, Dr. David Felton, to teach a workshop on writing for publication. Dr. Felton is now the Dean of the University of West Virginia School of Dentistry, but he was a faculty member at the UNC School of Dentistry for many years before his move to West Virginia. Dr. Felton has been the editor of the Journal of Prosthodontics for many years. Occasionally, we chat about editor topics, especially how we want to make our publications better for our professional colleagues. So we decided to join forces and teach a seminar on how to have success in publishing. Fortunately, there are many resources available to anyone who wishes to learn to write and contribute to the literature. Both of our respective publications are growing and expanding, which is always good news to report!

I am also excited to report on new changes you will see in the Journal of Dental Hygiene (JDH) starting this month. The members spoke and ADHA heard them loud and clear. This issue of the JDH represents the last one we will have in our former format. When the JDH transitioned to an online journal in 2004, we did not have many options. Now we do! More of our readers are demanding a format that is easier to access and read. HighWire Press is our new vendor and they also provide service to other well known publications such as the Journal of Dental Education and the Journal of the American Dental Association. Other exciting news is that we will be expanding the JDH so that members will have six issues per year. We are growing and our Journal is reflecting that growth.

I cannot stress how important it is for our members to read and contribute to the JDH. A profession is defined by its body of unique knowledge. The JDH is the premier publication of the American Dental Hygienists' Association and it is there to reflect changes in knowledge and research. Nelson Mandela once wrote that "Education is the most powerful weapon which you can use to change the world." The JDH is intended to keep dental hygienists educated about evidence based practice, new techniques for clinical care of patients, new advances in education and technology and much more.

We hope that you will be as excited about the changes in the JDH as we are!

Sincerely,

Rebecca Wilder, RDH, BS, MS
Editor-in-Chief, Journal of Dental Hygiene

Periodontal Pathogens and Reactivation of Latent HIV Infection: A Review of the Literature

Laura Jordan, RDH, BS

This project won 1st place in the ADHA Sigma Phi Alpha Journalism Award Competition, June 2012, under the baccalaureate or degree completion candidate category. Award provided by a generous grant from Johnson & Johnson Healthcare Products, Division of McNEIL PPC, Inc.

Abstract

Purpose: Infection by the human immunodeficiency virus (HIV) causes the host to have a compromised immune system due to the virus's ability to infect cells of the immune system, such as helper T-cells (specifically CD4+ T-cells), macrophages and dendritic cells. HIV remains latent within these cells, which function as memory cells and remains in the body for years. People who have a compromised immune system caused by HIV are more highly susceptible to other infections, including periodontal disease. Until recently, very little attention has been given to the potential interactions between chronic oral infections, such as periodontal disease and latent HIV reactivation/upregulation. This review focuses on the literature available between 2009 and 2011, evaluating the potential link between bacterial infections, including oral infections caused by periodontal pathogens, the reactivation of latent HIV leading to the potential failure of highly active antiretroviral therapy and acquired immunodeficiency syndrome (AIDS) progression. It has been hypothesized that infections by periodontal pathogens can stimulate reactivation of HIV-latently infected cells. Studies showed that soluble factors produced in response to periodontal pathogens by gingival cells could be indirect contributors to HIV-1 promoter activation. It was also found that the oral bacteria stimulated the HIV promoter activation in a dose-dependent and time-dependent manner. While these preliminary studies present a potential link between oral periodontal pathogens and HIV reactivation, additional clinical and epidemiological studies are needed to clarify the causal link and mechanisms of HIV latency reactivation associated with oral pathogens.

Keywords: Periodontal disease, HIV latency, HIV reactivation, AIDS, oral bacteria

This study supports the NDHRA priority area, **Clinical Dental Hygiene Care:** Assess how dental hygienists are using emerging science throughout the dental hygiene process of care.

Introduction

According to the World Health Organization, approximately 34 million people are infected with the human immunodeficiency virus (HIV), and although there have been many advances in HIV research in recent years, including therapies such as highly active antiretroviral therapy, this disease still constitutes one of the most significant public health problems in the world.[1] In the U.S. alone, the Center for Disease Control (CDC) estimates the number to reach 1.2 million in 2012.[2] Infection with HIV interferes with the immune system as a result of the virus's ability to infect cells of the immune system, such as helper T-cells (specifically CD4+ T-cells), macrophages and dendritic cells.[3-5] Once past this acute phase of the infection, HIV replicates at very low levels for the next 8 to 10 years. One of the difficulties in treating HIV infection stems from its ability to remain latent within these CD4+ T-cells, which function as memory cells and remain in the body for years.[4] People who have a compromised immune system caused by the HIV infection are more highly susceptible to other infections, including periodontal disease.[6]

According to the CDC, 75 to 90% of American adults have some form of periodontal disease (gingivitis or periodontitis).[2,6] Periodontal disease, whose primary etiology is bacterial biofilm, including Porphyromonas gingivalis, causes a chronic inflammatory response by the release of bacterial and host cell products.[3] P. gingivalis has previously been shown to be a significant risk factor for many systemic diseases, including heart disease, diabetes and low birth-weight, among others.[6] Recent studies suggest that bacteria found in the oral cavity, including P. gingivalis, have the ability to reactivate the latent HIV virus within infected cells.[3-5] A 2009 study suggests that P. gingivalis produces a fatty acid called butyric acid, which may induce reactivation of the latent HIV-1 virus.[3]

Since HIV infection is considered pandemic with over 34 million people worldwide living with the disease,[1] it is highly presumable that dental hygienists are encountering patients in their practices at all stages of infection. A large component of patient education provided by a dental hygienist consists of explaining the link between systemic disease and periodontal disease. Thus, for patients who have contracted HIV, discussing the possible link between HIV reactivation and periodontal pathogens could result in earlier risk identification and better control and prevention of disease progression.[7,8] Therefore, the purpose of this review is to look at the current literature available on the link between infection by oral pathogens and the reactivation of latent HIV virus leading to possible risk identification for prevention and control of disease progression.

Target Cells for HIV Infection and Latency

HIV can infect and integrate into dendritic cells, monocytes/macrophages and CD4+ T-cells, thus causing them to be long-lived reservoirs of the latent virus.[3-5,9] This pool of infected host cells is established during the early stages of acute HIV infection, and once integrated becomes virtually invisible to the immune system, and is one of the main reasons why complete eradication of the HIV infection cannot be currently achieved.[5,9] Due to these obstacles, there has been an increase in research using these cell types in the hopes of finding new treatments and better methods of prevention.[10]

Indirect Mechanisms of Periopathogens on HIV-1 Promoter Regulation

González et al looked specifically at the ability of supernatants (cytokines/chemokines) produced by human gingival fibroblasts (Gin-4) and oral epithelial cells (OKF4) to modulate HIV promoter activation in macrophages when challenged with periodontal pathogens.[5] BF24 monocytic cell lines were used which mimic a latent HIV-1 infection. These cell lines were transfected with a HIV-1 promoter, and then stimulated with the periopathogens P. gingivalis, Fusobacterium nucleatum or Treponema denticola. Both Gin4 and OKF4 supernatants enhanced HIV-1 promoter activation, with a notable enhancement when supernatants from OKF4 were challenged with extract from F. nucleatum and P. gingivalis. The cells that were pulsed with F. nucleatum showed a significant cytokine/chemokine increase in GM-CSF, Iterleukin-6 and Interleukin-8, which have the capacity to modulate HIV-1 promoter activation. In addition, González et al also evaluated the ability of supernatants from resident gingival cells and bacterial extracts from periodontopathogens to promote synergistic HIV-1 promoter activation.[5] There was a significant increase in activation of the HIV-1 promoter in BF24 macrophages incubated in media with increasing concentrations of T. denticola, P. gingivalis and F. nucleatum. The results indicated an increase in HIV-1 promoter activation as compared to the response when challenged by bacteria alone without supernatants. This effect was shown to be additive, not synergistic in nature.

Iami et al focused on the possible effects of infection with P. gingivalis on HIV-replication, thus leading to a progression towards AIDS.[3] The effects of P. gingivalis on HIV-1 latency were examined using human cell lines (ACH-2 and U1) derived from CD4+ T-cells and macrophage cells that were infected with the HIV-1 provirus. Their results showed that P. gingivalis facilitates the reactivation of latent HIV-1 cells through chromatin remodeling, which may indicate a pathophysiological link between HIV progression to AIDS and infection with P. gingivalis. Specifically, P. gingivalis produces butyric acid in concentrations in the significant range of 4.7 to 13.8 mM in dental plaque, which promotes expression of the HIV-1 latent virus, and implies that infection with P. gingivalis bacteria could be a risk factor in HIV-AIDS progression. This was one of the first studies to show a molecular link between AIDS progression and a bacterial metabolite.

Primary reactivation of HIV latently infected cells

In 2009, Huang et al evaluated the capacity of bacteria found in the oral cavity to stimulate HIV promoter activation.[4] A T-cell line (1G5), the macrophage line (BF24) and the THP-1 line were transfected with the HIV long terminal repeat promoter. These were then stimulated with bacterial sonicates from the following bacteria: P. gingivalis, Prevotella intermedia, F. nucleatum, Actinomyces viscosus, Aggregatibacter actinomycetemcomitans, Streptococcus mutans, Campylobacter rectus and Tannerella forsythia. When the 1G5 line was stimulated with sonicates, both the gram-negative and gram-positive species were able to elicit positive stimulatory activity. The BG24 macrophage lines were also tested on the same bacterial sonicates, and F. nucleatum showed significant increases at lower doses, while P. gingivalis showed a greater HIV promoter activation than T. denticola and F. nucleatum. S. mutans had a minimal effect on the macrophages. Different bacteria had different responses when

tested on dendritic cells, and although all of the bacteria did cause an increase in promoter activation, P. intermedia and C. rectus were the most effective.

Two years later, looking specifically at dendritic cells as reservoirs for the latent HIV virus that could be stimulated by oral bacteria leading to HIV reactivation, Huang et al obtained dendritic cells from the THP89GFP cells, which were then transfected with the HIV-1 genome.[9] The dendritic cells were then subjected to different bacterial challenges, including the following oral pathogens: P. gingivalis, S. mutans, F. nucleatum, Candida albicans and P. intermedia, using TNF as a positive control. They compared the reactions of both mature and immature dendritic cells to produce HIV promoter activation. They found that the oral bacteria activated the HIV promoter in the dendritic cells. There were significant differences between the reactions of individual bacteria, with P. gingivalis, P. intermedia and F. nucleatum having a significant effect on promoter activation, peaking at about 8 hours. An optimal dose of P. gingivalis, F. nucleatum and S. mutans was around 1x107/culture, with higher levels showing a decrease in HIV promoter activity. P. intermedia had a much larger range of stimulation, ranging from 1x106 to 2x107/culture. Consistent with what has been seen in previous studies, S. mutans and C. albicans had a significantly lower effect on HIV promoter stimulation than their Gram-negative counterparts. Huang et al also found that the oral bacteria stimulated the HIV promoter activation in a dose-dependent and time-dependent manner.[11]

Although there have been several studies that have investigated HIV reactivation by a monospecies challenge, there has been some recent interest in examining the effects of polymicrobial bacterial challenges, such as the synergistic colonies found in the subgingival biofilm of the oral cavity, which would better reflect in vivo conditions.[11] Therefore, building on their previous work, Huang et al evaluated the theory that HIV infected patients who have a polymicrobial oral co-infection, such as periodontitis, have a risk factor for HIV reactivation.[11] The cell lines used in this study were a monocytic leukemia subclone (BF24) and (THP-89GFP), infected with the HIV-1 strain. Huang et al chose the following pathogenic bacteria to mimic an oral infection: A. actinomycetemcomitans, P. gingivalis, P. intermedia, F. nucleatum, T. denticola, S. mutans, Streptococcus gordonii, and Streptococcus sanguinis. The different polybacterial and monobacterial treatments were exposed to the cell lines, and their responses measured using a Mann-Whitney U-test or Kruskal-Wallis analysis. The study grouped several types of bacteria together, such as P. gingivalis and P. intermedia, S. mutans, S. gordonii and S. sanguinis, as well as measured responses of the cell lines to bacteria such as A. actinomycetemcomitans, individually. The results revealed that that there was a significant difference in HIV reactivation of the BF24 and THP89GFP cell lines in the presence of Gram-positive versus Gram-negative bacteria and that many of the Gram-negative bacteria could act synergistically with each other to produce HIV promoter activation and viral replication. Gram-positive bacteria did not show any synergistic effects on the cell lines.

Discussion

The literature reviewed in this paper primarily encompasses research done since 2009 on the possible link between infection by oral pathogens and the reactivation of latent HIV virus leading to possible disease progression. To date, all the studies included in this review were performed on specific cell lines (macrophages/monocytes, CD4+T-cells, dendritic cells) infected with the HIV-1 provirus.[3-5]

The 2009 Iami et al study was one of the first studies to show a molecular link between AIDS progression and a bacterial metabolite, specifically butyric acid produced by P. gingivalis.[3] This study focused specifically on the ability of butyric acid to promote HIV reactivation in individuals infected with HIV-1. Although this study focused primarily on P. gingivalis as the primary producer of butyric acid, it should be noted that there are many other periodontopathogens that produce this short chain fatty acid. Further studies should include the use of Clostridium, Fusobacterium and Eubacterium, as well as several other microorganisms that produce butyric acid, which may also be implicated in the replication and reactivation of HIV-1.[5]

Following the work of Imai et al,[3] González et al conducted the first study to show soluble factors produced in response to periodontal pathogens by gingival cells could be an indirect contributor to HIV-1 promoter activation.[5] Although their research did provide a definitive link, the exact mechanisms used by oral bacteria to induce reactivation of HIV-1 in latently infected cells remains unclear.

Huang et al selected the following bacteria: P. gingivalis, P. intermedia, F. nucleatum, A. viscosus, A. actinomycetemcomitans, S. mutans, C. rectus and T. forsythia to test HIV reactivation in macrophages, dendritic cells and T-cells latently infected with HIV-1.[4,9,11] Different bacteria had different responses

when tested on dendritic cells, and although all of the bacteria did cause an increase in promoter activation, P. intermedia and C. rectus were the most effective.[4] Consistent with what has been seen in previous studies, S. mutans and C. albicans had a significantly lower effect on HIV promoter stimulation than their Gram-negative counterparts. Huang et al also found that the oral bacteria stimulated the HIV promoter activation in a dose-dependent and time-dependent manner.[9] These findings all suggest that oral infections are a potential risk factor for patients being treated for HIV infection. Therefore, reactivation of latent HIV in dendritic cells, monocytes/macrophages and CD4+ T-cells[3-5,9] may result in failure of highly active antiretroviral therapies and ultimately lead to AIDS progression. Future studies are needed to address the in situ occurrence of these processes, as well as the mechanisms responsible for the interactions between periodontopathogenic bacteria and HIV reactivation.[4,9,11]

Conclusion

Following the many advances in HIV research in recent years, and building on previous studies that have established oral pathogens as risk factors for many systemic diseases including heart disease and diabetes,6 interest has been generated in investigating the possible link between infection by oral pathogens and their ability to reactivate latent HIV virus in infected cells.[3-5] Despite the fact that this research is in the very early stages, several studies have shown a positive correlation between infection by bacteria found in the oral cavity and HIV promoter activation.[3-5,9,11] Due to the sensitive nature of working with individuals infected with HIV and the possibility of latency reactivation, the research currently being done will continue to be studied using cells lines cultured in laboratories. Although HIV is a highly complicated disease for which we have yet to find a cure,[5] these studies provide useful preliminary information that can be shared with patients regarding the status of their oral health and its possible relationship to their current HIV status.[1]2 Future laboratory and epidemiological studies are needed to clarify the causal link and mechanisms of HIV latency reactivation associated with oral pathogens that could lead to AIDS progression and possible failure of highly active antiretroviral therapies.[4,9,11]

Laura Jordan, BS, RDH, is currently employed at Murray Family Dentistry in Louisville, Colorado.

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Innovations in Education and Technology

Collaborative Learning in Pre–Clinical Dental Hygiene Education

Laura J. Mueller-Joseph, RDH, EdD; Luisa Nappo-Dattoma, RDH, RD, EdD

Abstract

Purpose: Dental hygiene education continues to move beyond mastery of content material and skill development to learning concepts that promote critical-thinking and problem-solving skills. The purpose of this research was to evaluate the effectiveness of collaborative learning and determine the growth in intellectual development of 54 first-year dental hygiene students.

Methods: The control group used traditional pre-clinical teaching and the experimental group used collaborative pedagogy for instrument introduction. All students were subjected to a post-test evaluating their ability to apply the principles of instrumentation. Intellectual development was determined using pre- and post-tests based on the Perry Scheme of Intellectual Development. Student attitudes were assessed using daily Classroom Assessment Activities and an end-of-semester departmental course evaluation.

Results: Findings indicated no significant difference between collaborative learning and traditional learning in achieving pre-clinical competence as evidenced by the students' ability to apply the principles of instrumentation. Advancement in intellectual development did not differ significantly between groups. Value added benefits of a collaborative learning environment as identified by the evaluation of student attitudes included decreased student reliance on authority, recognition of peers as legitimate sources of learning and increased self-confidence. A significant difference in student responses to daily classroom assessments was evident on the 5 days a collaborative learning environment was employed.

Conclusion: Dental hygiene students involved in a pre-clinical collaborative learning environment are more responsible for their own learning and tend to have a more positive attitude toward the subject matter. Future studies evaluating collaborative learning in clinical dental hygiene education need to investigate the cost/benefit ratio of the value added outcomes of collaborative learning.

Keywords: Classroom Assessment, Collaborative Learning, Dental Hygiene Education, Intellectual Development, Learning Environment Preference, Measure of Intellectual Development, Perry Scheme of Intellectual Development, Preclinical Course, Principles of Instrumentation

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

Introduction

The concluding decades of the twentieth century were rich in producing a better appreciation of the learning process. Critical to the comprehension of the process is the fundamental tenet of modern cognitive theory - learners must be actively engaged in their learning.[1] The Boyer Commission, along with the National Research Council and the National Science Foundation, advocates instructional innovation in education to foster higher levels of learning, as well as the development of communication, teamwork and lifelong learning.[2] This education paradigm shift involves active learning methodologies that encourage discussion and exploration of concepts enabling students to become involved in higher order thinking tasks, such as analysis, synthesis and evaluation. There is growing evidence that learning is about making connections. Learners must do the work of learning by actively making connections and organizing learning into meaningful concepts.[1]

This paradigm shift from passive to active learning pedagogy has also affected dental education. A report from the Institute of Medicine on the future of dental education recommends that more curriculum hours be shifted from lectures to guided seminars and other active learning strategies that develop critical thinking and problem-solving skills.[3] This change in the approach of teaching stems from the fact that learning outcomes involving higher order thinking skills are difficult to achieve in health relat-

ed disciplines that have clinical components because knowledge obtained in the classroom is not easily transferred to the clinical setting.[4-6]

The notion of improved learning is enhanced through the use of new pedagogies involving collaborative learning. Collaborative learning is an active learning approach that improves learning through student interaction. Increased student performance, as well as advancement in intellectual development, has been associated with the collaborative process of education.[7-9] Students in this type of learning environment learn not only from course instructors but also from their peers.

Pre-clinical courses in health related disciplines typically use a traditional model of instruction where students work independently from their peers. Although traditional models have been successful in developing students' pre-clinical skills, collaborative pedagogies offer a more complete approach to learning. Active learning strategies have been successful in statistics courses, and are implemented in engineering, medical and nursing programs.[10,11] The use of a collaborative learning environment has positively influenced dental hygiene students regarding the traits of social interaction, task management and trust.[12] Active learning strategies incorporate tasks that increase opportunities for intellectual development through the utilization of interactive group work.[10]

Extensive research on intellectual development has been conducted by William Perry.[13] His research demonstrated that intellectual development occurs in stages, and that not all college students are at the same level of intellectual development. He recommended pedagogical interventions to enable students to develop cognitive ability in fostering critical thinking skills inherent within intellectual development.[13]

The Perry Scheme is a dialectical theory adapted from the cognitive development theory of Piaget. Perry suggested that intellectual development in adults occurs in a similar fashion to that which Piaget proposed occurs in children.[13] Perry's Scheme suggests that development occurs as a result of cognitive disequilibrium. When individuals are presented with information that cannot be disseminated into their existing structure, they alter this pre-existing structure to incorporate the advanced complexity. Perry and his colleagues observed a consistent change in development within college education and theorized that this change was secondary to cognitive disequilibrium. Perry's model has been used extensively in research studies conducted within higher education in assessing the intellectual development of students within various disciplines. It has been applied to many areas of academia including mathematics, psychology, science, engineering, medicine, dental and dental hygiene.[14-16]

Perry's developmental scheme includes 3 major stages: dualism, multiplicity and contextual relativism, which focuses on intellectual development. One final stage, commitment in relativism, focuses on the development of identity. Intellectual development, as used by Perry, is defined in terms of increasingly complex cognitive skills along a progressive continuum. There are 9 positions associated within this continuum. Positions 1 and 2 relate to dualism, 3 and 4 to multiplicity, and 5 relates to contextual relativism. Positions 6 through 9 relate to the development of identity in lifelong learning and commitment to self in the contextual relativism stage.[13]

An individual at the dualist stage is one who is a dichotomous thinker, where truth is absolute, and there is only one right answer to every question. The student is the passive receiver of knowledge and is dependent on authority to deliver the truth. At Perry's multiplicity stage there is a dissipation of dualistic thinking and a broadening of the student's viewpoint that there can be more than one approach to a problem. Truth is perceived as personal and students come to believe that authorities do not have all the right answers as they evolve beyond diversity of option.[13]

Early multiplicity leads to the realization that truth is unknown but that learning the process in arriving at a solution will eventually discover the truth. Students begin to evolve beyond dependency on authority and acknowledge that everyone has a right to their own opinion. In late multiplicity, the student perceives that very little is known for certain and diverse viewpoints are valid.[13]

At the contextual relativism stage students recognize knowledge as relative and that knowledge and values are disconnected from absolute truth. An analytical, evaluation approach to knowledge is cultivated where opinions are based on evidence and appropriate reasoning processes.[13]

In commitment in relativism, individuals evolve in their thinking and gradually make a personal commitment as one establishes one's own identity. Initially, there is a coming to terms with one's commitments to a set of values, a career and spousal choice. The second aspect of this stage involves issues requiring an endpoint in ultimate commitment. This stage, with its relative positioning along the continuum, takes place later in life. It is clearly the longest stage in the Perry Scheme and lasts one's lifetime. The

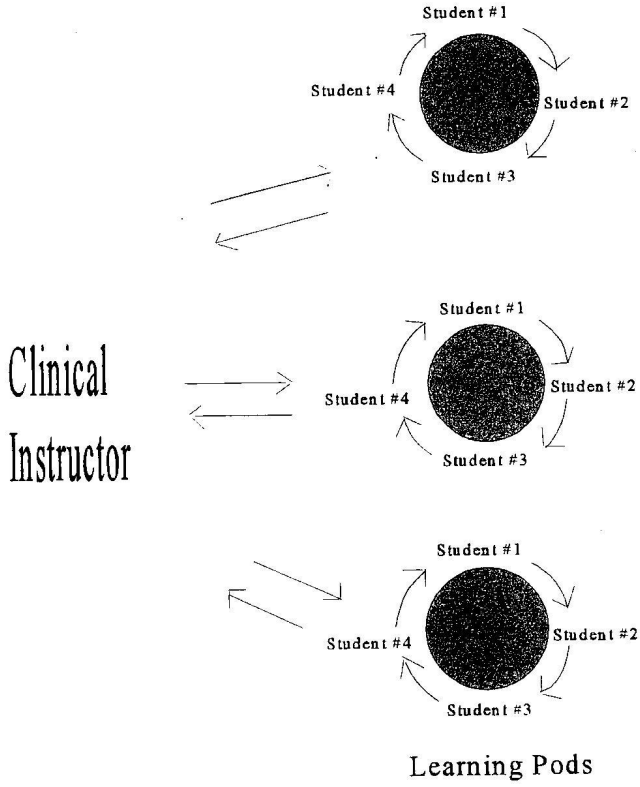
first 3 stages of the Perry Scheme are measurable throughout a student's college education. Therefore, for the purpose of this study, positioning along the first 3 stages was measured.

The purpose of this study was to design, implement and evaluate the effects of a collaborative pre-clinical model (CPCM) in dental hygiene education on learning outcomes and on the enhancement of intellectual development.

Description of a CPCM

The collaborative learning model used in this research focused on the application of instrumentation principles to various instruments used in dental hygiene treatment as taught in a pre-clinical course in the dental hygiene program at Farmingdale State College, State University of New York. The pre-clinical course is taught in conjunction with a preventive oral health concepts lecture. Students work together in the pre-clinical course for 8 hours per week. Throughout the semester time is allotted for demonstration and mini lectures. The collaborative learning model replaced the instrument demonstration component of the pre-clinical course. Collaborative groups of 4 were established and student roles within the groups were based on the 4 principles of instrumentation (grasp, fulcrum, adaptation, stroke). These collaborative groups were utilized throughout the semester as various instruments were introduced. During these collaborative activities faculty acted as facilitators rather than authority figures encouraging open lines of communication. Figure 1 depicts the general communication flow within the suggested pre-clinical collaborative model.

Figure 1: Communication Flow in Pre-Clinical Collaborative Learning Model



The clinical instructor assumes the role of facilitator and students work interdependently with their peers.

Methods and Materials

A randomized, 2 group research design was employed to test the effectiveness of collaborative learning in pre-clinical dental hygiene education and the advancement of intellectual development along Perry's Scheme.[13] The independent variables under investigation consisted of traditional clinical teaching (control group) and collaborative learning methodologies (experimental group). Students were randomly assigned to 1 of these 2 groups (n=26 control, n=28 experimental). The dependent variables were represented by the principles of instrumentation and the advancement of intellectual development along Perry's Scheme. Measurement of the dependent variables consisted of a pre-clinical post-test that evaluated the application of instrumentation principles and 2 pre- and post-tests to assess students' intellectual positioning on Perry's Scheme. These intellectual development pre- and post-tests were the Learning Environment Preference (LEP) and the Measure of Intellectual Development (MID) instruments.[17-19]

The traditional pedagogy, used as the control, followed a rote learning method of instrument introduction. In this approach, students gather around an instructor for a demonstration of instrument usage. These demonstrations took place throughout the semester as each new instrument was introduced. Following the demonstration students paired up and practiced on each other with direct 1-to-1 faculty supervision.

The application of collaborative learning focused on the principles of instrumentation. New instruments were introduced 5 times throughout the semester, and students worked in small groups on clinical manikins to problem solve the application of instrumentation principles. To promote group interdependence each member within the learning group was responsible for 1 of the principles of instrumentation. Roles within the group were rotated on a regular basis to ensure complete learning of the principles. The activities consisted of 4 to 6 open-ended, short answer questions designed to facilitate critical thinking. The initial exercise focused on instrument design, indication for use, grasp, fulcrum, adaption, stroke and patient/operator positioning. Subsequent exercises asked students to problem solve the principles

of instrumentation in comparison to each new instrument introduced. These activities acted as a problem solving guide while faculty were facilitators to redirect the student's thought process if they were unable to solve the problem.

The pre-clinical post-test was designed to evaluate the students' ability to apply the principles of instrumentation to 3 unfamiliar instruments. The instruments used in the post-test included the Gracey 13/14, Gracey 9/10 and the Langer 17/18. The purpose for using unfamiliar instruments was to eliminate the possibility of memorization. In pre-clinical instrumentation, students often memorize instrument usage based on the number engraved on the instrument handle. This evaluation was directed at higher order thinking skills and asked the students to critically think, analyze and apply their pre-clinical knowledge.

The practical instrumentation post-test was performed on a typodont during the last 2 weeks in the semester in a small classroom close by the clinic. Three unfamiliar instruments were presented to the students, who were then asked to determine how these instruments should be used according to the principles of instrumentation. Students were given approximately 15 minutes to complete the evaluation. The post-test evaluation was not part of the students' pre-clinical grade and had no bearing on student success in the course. Students were evaluated individually by an impartial examiner from New York University College of Dentistry who had no connection to the dental hygiene department at Farmingdale State College. The examiner was a dental hygienist who had experience in teaching and evaluating dental hygiene students in pre-clinical instrumentation. Scoring of the post-test involved direct observation and evaluation of instrumentation skill. Scores ranged from 0 to 4 for each stated criteria associated with the 4 principles of instrumentation. A score of 4 indicated that the student performed the stated criteria 90 to 100% of the time, a score of 3 indicated 80 to 90% achievement, a score of 2 indicated 70 to 80% achievement and a score of 1 indicated 60 to 70% achievement. Finally, a score of 0 indicated that the criteria were not met.

The instruments used in measuring intellectual development in this study included the objective LEP developed by Moore and the essay style MID developed by Knefelkamp and Widick.[17-19] The MID is considered the primary research instrument for the measurement of intellectual development in Perry's Scheme. The current version is a single essay, A or AP, which focuses on the student's "ideal learning environment," and essay Q as a post-class experience. The MID provides a single Perry score for the individual essay responses and is scored by 2 trained raters at the Center of Intellectual Development (CSID).[20] Ratings are represented by a 3 digit number indicating the dominant and sub-dominant positions or transitions in cognitive development and reflect a qualitative perspective. The MID ratings may be used as a dependent measure and treated as an interval scale for purposes of data analysis and are subsequently converted to numerical scores.[21] For example, 455 is converted to 4.67 and so forth. Traditional approaches to psychometric reliability, such as short-term repeated administration and split/half procedures of the MID, are difficult. Reliability measures include correlations with interviews, correlations with expert outside raters and inter-rater reliability data.[21] Inter-rater reliability can be determined by the absolute position agreement or within one-third of a position agreement. An absolute agreement of inter-rater reliability of 51.2% and an inter-rater figure of 93.6% within one-third of a position in evaluating 1,244 essays has been reported. The validity of the MID has been assessed in a variety of ways. A 0.45 and 0.13 correlation between the MID and Rest's Defining Issues Test, which measures moral judgment, has been determined. Also the LEP and MID averaged a correlation of 0.36.[21]

The LEP is a relatively new objective-style paper and pencil measure of intellectual development in Perry's Scheme. The LEP reflects a quantative perspective of the MID in that it focuses primarily on the intellectual portion of Perry's Scheme and consists of positions 1 through 5. The tests consist of 65 items across 5 domains: view of knowledge/learning, role of the instructor, role of the student/peer, classroom atmosphere/activities and role of evaluation/grading. The 5 domains focus on student preferences for specific aspects of a classroom environment in association with increasing complexity along the Perry Scheme. It also reflects the major cue categories used in rating the MID. The LEP assigns 1 cue per domain on direct quotes of the MID. The statement cues progress from least complex to most complex statements. The mixture in complexity helps to ascertain whether respondents are selecting responses due to complexity or their cognitive positioning. Scoring is also conducted by the CSID. Scores range from a 200 (stable position 2) to 500 (stable position 5).[22]

Reliability for the LEP has been determined in 2 traditional approaches. Internal consistency using Cronbach's coefficient alpha was computed for each domain and each position across the 5 domains.[23] The alpha reliability ranged from 0.63 on the "role of evaluation" to 0.84 for positions 4 and 5. Test/re-test reliability was performed on 30 subjects. The Cognitive Complexity Index demonstrated a test and re-test correlation of 0.89, indicative of a reasonable amount

Table I: Mann-Whitney Comparison of Instrumentation Post-Test Scores

Instrument / Principle of Instrumentation	Traditional Group		Collaborative Group		z=	p=
	Median	IQR*	Median	IQR*		
Langer 17/18						
• Grasp	16	12 to 16	16	13 to 16	-0.63	0.52
• Fulcrum	12	12 to 12	12	12 to 12	0.20	0.84
• Adaptation	8	4 to 10	8	4 to 9	-0.01	0.99
• Stroke	16	12 to 20	16	15 to 20	-1.19	0.23
• Total	52	45 to 56	53	48 to 57	-0.99	0.32
Gracey 13/14						
• Grasp	16	10 to 16	16	12 to 16	-0.06	0.94
• Fulcrum	12	12 to 12	12	12 to 12	-0.75	0.45
• Adaptation	4	4 to 8	5	4 to 8	-0.11	0.91
• Stroke	16	13 to 20	20	16 to 20	-1.87	0.06
• Total	48	44 to 56	53	49 to 56	-1.26	0.20
Gracey 9/10						
• Grasp	16	11 to 16	16	12 to 16	-0.67	0.50
• Fulcrum	12	10 to 12	12	12 to 12	-1.96	0.05
• Adaptation	8	4 to 11	8	4 to 11	-0.04	0.96
• Stroke	16	11 to 20	20	16 to 20	-1.06	0.10
• Total	48	40 to 59	55	44 to 59	-1.17	0.23

of stability for the measure in that time frame. Intercorrelations of the MID with the Cognitive Complexity Index are 0.36 and 0.25 for MID and GPA.[23]

Students were asked to complete the LEP pre-test on the first day of the fall semester. The instrument was a rating test that took 30 minutes to administer. Students were also given instruction on how to complete the MID essay as a take home assignment and to return the Essay AP the following class session. Both the LEP and MID were mailed to CSID for scoring. Scores are designed to measure patterns of longitudinal intellectual development across groups of students or as a pre-/post-evaluation of courses.

During the last class session students in both groups were asked to complete the LEP and MID Essay Q post-tests. The post-tests were also mailed to CSID for scoring and reconciliation.

Qualitative analysis was employed to analyze student perceptions of their pre-clinical experience using emerging themes. Written assessment of each class session was collected each day through daily classroom assessment activities adopted from Angelo and Cross[20] and an end-of-semester evaluation consisting of open-ended and likert scale questions assessed students' final perceptions of the preclinical course.

Results

The pre-clinical post-test evaluated student ability to apply the principles of instrumentation to 3 unfamiliar instruments: Langer 17/18, Gracey 13/14 and Gracey 9/10. The Mann-Whitney statistical test was used to compare distributions between the collaborative and traditional groups (Table I). Findings demonstrated no statistically significant differences between groups for all instruments with respect to the variables of grasp, adaptation and stroke. The variable of fulcrum did not demonstrate a significant difference between groups for the Langer 17/18 and Gracey 13/14, however, a statistically significant difference for fulcrum was noted for the Gracey 9/10 ($z=-1.96$; $p=0.05$), indicating that students in the collaborative group applied the principle of fulcrum better than the traditional group.

Both the MID and LEP were analyzed using an Analysis of Covariance (ANCOVA). The covariant was the pre-test scores for both instruments, and the outcome was the post-test scores, while the grouping factor was the different educational environment. For the MID scores the ANCOVA indicated that there was no relationship for the pre- and post-test scores ($F=31$; $df=1$; $p=0.58$), and no significant difference for the 2 groups ($F=0.68$; $df=1$; $p=0.41$). However, the ANCOVA demonstrated a significant relationship between pre- and post-test scores for the LEP ($F=4.01$; $df=1$; $p=0.05$) but no significant difference between the 2 groups ($F=0.99$; $df=1$; $p=0.32$). According to Knefelkamp early and late multiplicity stages are the lengthiest developmental periods within student development.[15]

Data collected from the Likert scale portion of dai-

Table II: Student Attitudes Toward the Preclinical Learning Environment* – Clarity of the Clinic Session

Responses	Session 1		Session 2		Session 3		Session 4		Session 5	
	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.
Totally Unclear	1 (4%)	0	0	0	0	0	0	0	0	0
Somewhat Clear	3 (12%)	1 (4%)	0	0	0	0	1 (4%)	0	0	0
Mostly Clear	7 (27%)	8 (30%)	4 (13%)	5 (18%)	5 (22%)	3 (11%)	4 (17%)	6 (21%)	3 (12%)	1 (4%)
Very Clear	7 (27%)	10 (37%)	10 (42%)	12 (43%)	8 (31%)	8 (30%)	12 (52%)	10 (36%)	12 (46%)	4 (15%)
Extremely Clear	8 (31%)	8 (30%)	10 (42%)	11 (40%)	10 (43%)	16 (59%)	6 (26%)	12 (43%)	11 (42%)	22 (81%)
Fisher's Exact Test	0.73		1.00		0.55		0.36		0.008**	

*Data represents the clinic days in which new instruments were introduced as reported by the daily classroom assessment activities.
**p<0.05

Table III: Student Attitudes Toward the Preclinical Learning Environment* – How Interesting was the Clinic Session?

Responses	Session 1		Session 2		Session 3		Session 4		Session 5	
	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.
Totally Boring	5 (19%)	0	0	0	0	0	1 (4%)	0	0	0
Mostly Boring	13 (50%)	0	2 (8%)	0	0	0	1 (4%)	0	0	0
Somewhat Interesting	5 (19%)	2 (7%)	4 (16%)	3 (11%)	7 (30%)	1 (4%)	6 (26%)	2 (7%)	5 (19%)	0
Very Interesting	13 (50%)	12 (44%)	11 (44%)	11 (39%)	8 (35%)	8 (29%)	9 (39%)	10 (32%)	13 (50%)	5 (19%)
Extremely Interesting	8 (31%)	8 (31%)	8 (32%)	14 (50%)	8 (35%)	19 (69%)	6 (26%)	16 (57%)	8 (31%)	22 (81%)
Fisher's Exact Test	0.28		0.35		0.01**		0.04**		0.003**	

*Data represents the clinic days in which new instruments were introduced as reported by the daily classroom assessment activities.
**p<0.05

ly classroom assessment activities revealed no individual differences within student responses over the course of the semester, but overall group differences did exist for the clinic days in which the pre-clinical pedagogy was significantly different (Tables II-IV). As time progressed the 2 groups diverged in the proportion of students who found the pre-clinical sessions extremely clear, interesting and useful. There was a large difference in comparison to the beginning of the semester when the response rate was equal between groups. It appeared that the collaborative group perceived the pre-clinical sessions had greater clarity, were more interesting and more useful as compared to the traditional group. The Fisher's Exact test revealed a significant difference between groups as evidenced on session 5 for clarity (Fisher's Exact=0.008), sessions 4 and 5 for how interesting (Fisher's Exact=0.04 and 0.003, respectively) and usefulness on session 5 (Fisher's Exact=0.03).

Coding themes generated from the open-ended portion of the classroom assessment activities revealed that 42% of students in the collaborative group, as compared to 0% of students in the traditional group, identified help from fellow students as an important part of the pre-clinical sessions. Also, 29% of students from the collaborative group and 62% of students in the traditional group identified help from the instructor as most helpful in clinic (Table V).

Table IV: Student Attitudes Toward the Preclinical Learning Environment* – Usefulness of the Clinic Session

Responses	Session 1		Session 2		Session 3		Session 4		Session 5	
	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.	Trad.	Coll.
Useless	0	0	0	0	0	0	0	0	0	0
Not Very Useful	0	0	0	0	0	0	1 (4%)	0	0	0
Somewhat Useful	0	2 (7%)	5 (20%)	4 (14%)	5 (22%)	1 (4%)	4 (17%)	3 (11%)	3 (12%)	1 (4%)
Very Useful	15 (58%)	13 (48%)	8 (32%)	11 (39%)	7 (30%)	7 (29%)	13 (57%)	11 (36%)	13 (50%)	6 (22%)
Extremely Useful	11 (42%)	12 (44%)	12 (48%)	13 (46%)	11 (48%)	16 (67%)	5 (22%)	14 (50%)	10 (38%)	20 (74%)
Fisher's Exact Test	0.57		0.82		0.11		0.12		0.03**	

*Data represents the clinic days in which new instruments were introduced as reported by the daily classroom assessment activities.
**$p<0.05$

Percentages of responses to each of the questions in the departmental end-of-semester course evaluation questionnaire indicated no significant difference between groups when the percentages were compared using the Fisher's Exact test. Although not statistically significant, meaningful results were obtained. Forty-six percent of students in the collaborative group, as compared to 22% in the traditional group, felt they learned the principles of instrumentation extremely well, while 57% of students in the collaborative group and 35% of students in the traditional group felt they strongly increased their commitment to the profession.

Table V: Student Attitudes Toward the Preclinical Learning Environment* – Emerging Themes

Found Most Helpful:		
Emerging Themes	Traditional n=26	Collaborative n=28
Help from Fellow Students	0	12 (42%)
Learning of Instrumentation Principles	4 (15%)	4 (15%)
Help from Instructor	16 (62%)	8 (29%)
Practice Time	6 (23%)	4 (15%)
How Class Could Be Improved:		
Emerging Themes	Traditional n=26	Collaborative n=28
More Help from Instructors	6 (38%)	13 (46%)
More Time to Practice	10 (62%)	11 (39%)
No Improvements Needed	0	4 (15%)

*Data represents the emerging themes associated with the open-ended questions in the daily classroom assessment

Discussion

Collaborative learning as an active learning approach did not promote intellectual development or improve learning outcome when compared to traditional pre-clinical teaching. However, it can be inferred from this investigation that the students' learning was not impeded by the use of collaborative learning. Although collaborative learning is a pedagogically sound alternative for traditional preclinical teaching in dental hygiene, critical thinking skills were not enhanced.

Critical thinking is the ability to evaluate, make judgments and apply knowledge to meet a challenge presented by a new experience or situation. As revealed in this investigation, students were not able to apply the principles of instrumentation when presented with unfamiliar instruments. The pre-clinical post-test evaluation demonstrated that there was no significant difference between the groups except for the variable of fulcrum on the Gracey 9/10. The fact that students were unaware that the instruments evaluated in the post-test were different than the instruments used in their pre-clinical experience represents a limitation in this post-test design. Future studies should emphasize to the students that unfamiliar instruments would be present in the post-test evaluation.

The advancement in intellectual development along Perry's Scheme did not differ significantly between a collaborative pre-clinical environment compared to a traditional environment. However, it is difficult to see change or advancement in intellectual development in dental hygiene education because

traditionally there is a teaching-learning environmental pressure of emphatic reliance on mastering the "correct technique" in the development of pre-clinical skills. The demand of developing correct dental hygiene instrumentation technique lends itself to maintaining the characteristics of early multiplicity in the students' perception of the instructor being the source of the "right way" regardless of learning environment.

Overall, students' perceptions and attitudes concerning pre-clinical dental hygiene education were the same for both groups, indicating that all students were satisfied with their pre-clinical experience. It was anticipated by the researchers that students in the collaborative group would feel more frustrated at the beginning of the semester because of the ambiguity of the collaborative learning process. However, results showed that students were receptive to the process. This may have been due to the fact that they knew they were participating in a research project, a limitation of the study.

Although all students found their pre-clinical experience satisfactory, significant differences were noted in the students' responses to individual pre-clinical sessions associated with the introduction of new instruments. It was evident from the research that students in the collaborative group found the individual pre-clinical sessions that introduced new instruments to be more clear, useful and interesting than did students in the traditional group. It can be inferred that the reason there was no significant difference between groups is that both groups were clearly in the dualistic phase of development. As time progressed the collaborative group may have better acclimated to the challenge and support of a collaborative environment. It is important to note that these pre-clinical sessions represented the different pre-clinical pedagogies used in the study. Therefore, it can be inferred from these findings that dental hygiene students in the pre-clinical setting found the collaborative pedagogy to be beneficial.

Lastly, students in both groups identified instructor assistance and practice time as important in the learning process. This is most likely related to the students' insecurity with learning a new skill in a new environment. However, students in the collaborative group also identified help from their peers as influential in their learning. As illustrated by a student responding to the daily classroom assessment activity, "listening and watching each other helped bring all the fundamentals together." This finding was not apparent in the traditional group, suggesting that collaborative learning assisted students in recognizing their peers as legitimate sources of learning.

Conclusion

Advancement in intellectual development was not significant in the collaborative group as compared to the traditional group. Perhaps the fact that collaborative pedagogy was employed only on the 5 days in which a new dental instrument was introduced may not have been enough collaborative intervention to foster intellectual growth. Although students were responsible for their own learning of the new scaling instrument they still perceived an emphasis on being perfect with their skill development. The pre-clinical environment might stifle intellectual development secondary to the nature of the discipline of clinical dental hygiene.

Another observation was that the MID essay question on post-test may have been misinterpreted by the students. Although the essay asked the students to define their experience in this pre-clinical course, the responses reflected harsh opinions of the entire first semester of classes within the dental hygiene curriculum and not just the course under investigation. This may have been problematic in scoring the essay in rating them for proper Perry positions.

The value added outcomes realized through the collaborative process are congruent with the work of Bruffee and Gamson who suggest that students involved in collaborative learning are more responsible for their own learning, tend to have a more positive attitude toward the subject matter, increase their tolerance for diversity of opinion, improve their interpersonal skills and enhance self-esteem.[7,8,24] Future studies evaluating collaborative learning in clinical education need to investigate the cost/benefit ratio of these value added outcomes. Collaborative pedagogy in didactic and clinical course across the dental hygiene curriculum would provide the foundation to foster a shared community of learners.

Laura J. Mueller-Joseph, RDH, EdD, is a professor and chairperson at the Department of Dental Hygiene and Acting Assistant Dean, The Theresa Patnode Santmann School of Health Sciences. Luisa Nappo-Dattoma, RDH, RD, EdD, is an associate professor at the Department of Dental Hygiene. Both are faculty at Farmingdale State College, State University of New York.

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Chronic HPA Axis Response to Stress in Temporomandibular Disorder

Cynthia A. Lambert, CDA, RDH, MS; Anne Sanders, MS, PhD, MS; Rebecca S. Wilder, BSDH, MS; Gary D. Slade, BDSc, DDPH, PhD; Stan Van Uum, MD, PhD, FRCPC; Evan Russell, MSc; Gideon Koren, MD, FRCPC, FACMT; William Maixner, DDS, PhD

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Abstract

Purpose: Perceived stress is associated with temporomandibular disorder (TMD), but whether cortisol levels are elevated in individuals with TMD is unknown. We hypothesized that cortisol concentration, a biomarker of hypothalamic-pituitary-adrenal (HPA) axis function, was elevated in TMD cases relative to controls, and that perceived stress was positively correlated with cortisol concentration.

Methods: In this case control study, TMD case status was determined by examiners using TMD Research Diagnostic Criteria. Participants (n=116) aged 18 to 59 years were recruited from within a 50 mile radius of the University of North Carolina at Chapel Hill. Following examination, cases (n=45) and controls (n=71) completed the 14-item Perceived Stress Scale using a reference interval of the past 3 months. Approximately 100 strands of hair were cut from the posterior vertex segment of their scalp. The 3 centimeters of hair most proximal to the scalp was analyzed with a commercially available salivary cortisol enzyme immunoassay adapted for hair cortisol. This length corresponds to the last 3 months of systemic HPA axis activity.

Results: TMD cases perceived higher stress than controls ($p=0.001$). However, hair cortisol concentration was lower in TMD cases than controls ($p<0.001$). The correlation coefficient revealed a weak negative relationship ($r=-0.188$) between perceived stress and hair cortisol concentration ($p=0.044$). In analysis stratified by case status, the relationship of perceived stress and hair cortisol concentration was non-significant for cases ($p=0.169$) and controls ($p=0.498$).

Conclusion: Despite greater perceived stress, TMD cases had lower hair cortisol concentrations than controls and the 2 measures of stress were weakly and negatively correlated.

Keywords: Temporomandibular joint disorders; Epidemiology; Factor, psychosocial; Hormones, hypothalamic pituitary regulating

This study supports the NDHRA priority area, **Clinical Dental Hygiene Care:** Investigate the links between oral and systemic health.

Introduction

One of the most fundamental physiological responses to stress is activation of the hypothalamic-pituitary-adrenocortical (HPA) axis. The end product of HPA axis activation is stimulation of the adrenal cortex to increase secretion of the glucocorticoid cortisol. While protective in the short term, sustained activation of this hormonal response system is theorized to lead to tissue damage and subsequent dysregulation of biological systems.[1] Since the 1960s, investigators have measured cortisol levels in blood, saliva or urine to understand how stress increases vulnerability to disease.

Well before the role of HPA axis was theorized, stress was recognized to contribute to acute necrotizing ulcerative gingivitis, so-called "trench-mouth," among WWI soldiers. Today, stress has salience to oral health research because it is implicated in the pathogenesis of several dental conditions that have relevance to dental hygiene clinical practice. Heightened levels of stress are associated with oral mucosal lesions such as oral lichen planus[2,3] and recurrent aphthous stomatitis.[4] Among middle-aged adults, those with greater perceived stress were less likely to have retained 20 teeth,[5] the minimum number required for adequate function.[6] Psychosocial stress is believed to increase susceptibility to gingival infection and depress immune responsiveness to periodontal pathogens.[7,8] A cross-sectional study

of 1,426 adults found that financial strain was associated with greater clinical attachment loss and alveolar bone loss.[9]

Perhaps the strongest evidence for a putative role of stress in oral disorders comes from studies of the onset, severity and chronicity of temporomandibular disorders (TMD). TMD is the most common form of chronic orofacial pain, affecting 5% of the U.S. population.[10] Sanders et al demonstrated a strong dose-dependent relationship between severity of perceived stress and odds of examiner-determined TMD.[11] Baseline findings from the OPPERA prospective cohort study investigating risk factors for TMD found that compared with controls, TMD cases reported higher levels of psychosocial symptoms, affective distress, somatic awareness and pain catastrophizing.[12] Longitudinal research that followed healthy adults with no prior history of TMD found that those with greater perceived stress were more likely to experience first-onset TMD than adults with less perceived stress.[13]

It is perhaps surprising that cortisol measurement does not feature more prominently in oral health research as a biomarker of stress. New protocols for salivary cortisol collection offer advantages over blood and urine sampling protocols in terms of cost and simplicity. Yet major difficulties remain in obtaining valid and reliable measurements of cortisol in observational studies. Firstly, cortisol secretion follows a robust 24 hour rhythm, peaking around 8:00 with a nadir between 20:00 and 24:00.[14] Overlying this daily pattern is a series of 8 to 10 pulses. Such variation means that exact timing of specimen collection is critical if cortisol concentrations are to be meaningfully compared, and multiple measures per subject are often required. The United States National Longitudinal Study of Adolescent Health recently reported its decision to drop salivary cortisol measurement from its protocol because responses and protocol adherence were inadequate.[15]

A second limitation of cortisol measurement in blood, saliva and urine is that each of these fluids provides a very limited temporal window of cortisol activity. Levels of cortisol in blood and saliva reflect average hormone levels in the past 1 hour while cortisol in urine captures a slightly longer interval of up to 24 hours. None of these are able to measure chronic stress exposure which is thought to pose a greater threat to health than the short-term physiologic responses to acute stress.[16,17]

An important breakthrough was the development of an assay to measure endogenous concentrations of cortisol in human scalp hair,[18] permitting a reliable measurement of the stress response over a prolonged period, (e.g., chronic stress exposure).[19] Cortisol is thought to be incorporated into hair through diffusion from body secretions of sweat and sebum during formation of the hair shaft.[20] Since hair grows at a precise rate of 0.35 mm per day, equivalent to 1 cm per month,[21] hair length is an accurate index of exposure to stress over time. Thus hair cortisol promises a new, simple and non-invasive way in epidemiologic research to examine the role of stress.

To clarify the role of stress in TMD, the first aim of this study was to confirm the well-documented association between perceived stress and TMD. Once established, the second aim was to determine the relationship between hair cortisol concentration and TMD status. The third aim was to examine the correlation between perceived stress and hair cortisol concentration. The authors tested the hypotheses that both perceived and biologic measures of stress were elevated among TMD cases and that perceived stress was positively correlated with hair cortisol concentration.

Methods and Materials

This study was approved by the University of North Carolina Biomedical Institutional Review Board. All participants gave written informed consent before their inclusion in the study. In this case control study, cases had examiner-diagnosed TMD. Controls were also examined and found not to have this condition.

Setting

During the period July 2010 to October 2011, potential participants were recruited by advertisements placed in brochures, on the internet, radio and newspapers within a 50 mile radius of the Center for Neurosensory Disorders, School of Dentistry at the Center for Neurosensory Disorders, the University of North Carolina at Chapel Hill.

Inclusion and Exclusion Criteria

Criteria eligible participants were males and females between 18 to 60 years of age with scalp hair at least 3 cm in length. Respondents were first screened in a telephone interview to exclude those with conditions known to influence cortisol levels. Exclusionary criteria were diagnoses of any one of Cushing's syndrome or Addison's disease, diabetes, heart trouble or disease, hypertension that was not well controlled with medication, hyperthyroidism, major psychiatric disorder requiring hospitalization within the previous 6 months, chronic respiratory

disease not controlled with medication, seizures, renal failure or dialysis. Also excluded were those who were pregnant, nursing, undergoing orthodontic treatment, radiation or chemotherapy, as well as persons with drug or alcohol abuse, trauma or surgery on the head, face or neck within the last 6 months. Persons having used corticosteroid treatment in the last 12 months (including cortisol containing creams, lotions and nasal spray) were likewise excluded. Finally, those having used permanent or semi-permanent hair color within 3 months were excluded since cortisol levels are lower in artificially colored hair.[18]

TMD Case Classification

A medical history was recorded for all screened participants prior to the clinical examination. Examinations were performed by 6 dental hygiene examiners trained in the examination protocol and calibrated for reliability and validity of their diagnostic decisions every 6 months. The standardized physical examination of the head and neck followed the research diagnostic criteria for TMD.[22] In summary, TMD cases were people who reported a 6 month history of pain in the temporomandibular structures, with at least 5 days of such pain in the month preceding the examination and where the examiner found at least 3 muscle groups in the temporomandibular region that were tender to palpation or jaw maneuver. Controls reported no history of orofacial pain within the preceding 6 months and no prior diagnosis for TMD. Additionally, their examination confirmed that they did not have TMD, arthralgia or myalgia.

Hair Sampling

A hair sample (approximately 100 strands, ≥20 mg of hair) of at least 3 cm in length was collected by study personnel. The sample was cut using fine scissors from as close as possible to the scalp from the vertex posterior region. Intra-individual variation in cortisol content is less in this region (coefficient of variation=15.6%), as compared to hair sampled from other than in the posterior vertex, anterior vertex, nape, temporal and frontal regions (coefficient of variation=30.5%).[18] Because scalp hair grows 1 cm per month on average,[23] analysis of 3 cm of hair most proximal to the scalp provides information about 3 months of systemic cortisol exposure. Hair samples were attached to a sheet of paper using Millipore tape (Billerica, Mass.), the scalp end was marked and the collection date and participant identification number were recorded. The paper was then enclosed in an envelope sealed with identification number and date on outside of envelope and stored at room temperature. Within 6 months of collection, samples were sent by mail to the laboratory at the University of Western Ontario, London, Ontario where cortisol levels were analyzed.

Hair Sample Preparation and Quantification of Hair Cortisol

In preparation for analysis, hair samples were measured and the length and color of the hair recorded. The most proximal 3 cm hair segment was cut, placed into a glass vial, labeled and weighed to ensure a minimal weight for analysis of 10 to 15 mg. Hair was then washed twice by immersing the segments in 3 ml of isopropanol, followed by a 3 minute incubation on a shaker at 0.11 g (100 rpm) at room temperature. Laboratory analysis was performed using a commercially available salivary cortisol enzyme immunoassay kit from Alpco Diagnostics (Salem, NH). Details of the laboratory procedures are reported fully elsewhere.[24]

Perceived Stress

Perceived stress was measured using the psychometrically-validated and widely used 14-item Perceived Stress Scale (PSS).[25] Summary scores from this instrument and its shorter 10-item subset are shown in previous studies to be positively associated with TMD.[13,26] The PSS was developed to evaluate the theoretical construct of stress proposed by Lazarus and Folkman[27] that a stimulus is stressful when perceived as both threatening and exceeding one's coping resources. The PSS takes into account these appraisals by measuring the degree to which respondents consider their lives to be unpredictable, uncontrollable and overloaded.[25] In each question, respondents were asked to indicate how often they felt or thought a certain way. The conventional 1 month reference interval was extended in this study to 3 months. This was considered to better represent exposure to chronic stress than the 1 month interval, without being so long that recall bias would limit the interpretation of findings. Responses were recorded on a 5-point ordinal scale coded: never=0, almost never=1, sometimes=2, fairly often=3 and very often=4. In computing a summary score, positively worded items were reverse coded, consistent with recommended scoring methods.[25]

Covariates

Covariates were sex, age in years, race, ethnicity, educational attainment, annual household income and cigarette smoking status. This information was obtained by questionnaire at the time of the physical examination.

Statistical Analysis

Participants with hair cortisol concentrations >1500 ng/g were excluded from analysis on the basis of possible contamination due to use of creams or ointments containing hydrocortisone.[28] Initial exploration using histograms and qnorm diagnostic plots showed that PSS scores were normally distributed, and cortisol concentrations were skewed towards higher values. Therefore log10 transformed cortisol values were modeled when the continuous values were analyzed. To account for the potential effect of confounding, analyses were repeated after stratifying on TMD case status.

The Pearson's product moment correlation coefficient was used to determine the strength and direction of the relationship between PSS scores and cortisol concentration. A scatter plot was fitted to graphically depict this relationship. Fisher's exact test was used to compare dichotomous variables and the independent samples t-test (2-sided) compared differences in mean log10 cortisol concentration between TMD cases and controls.

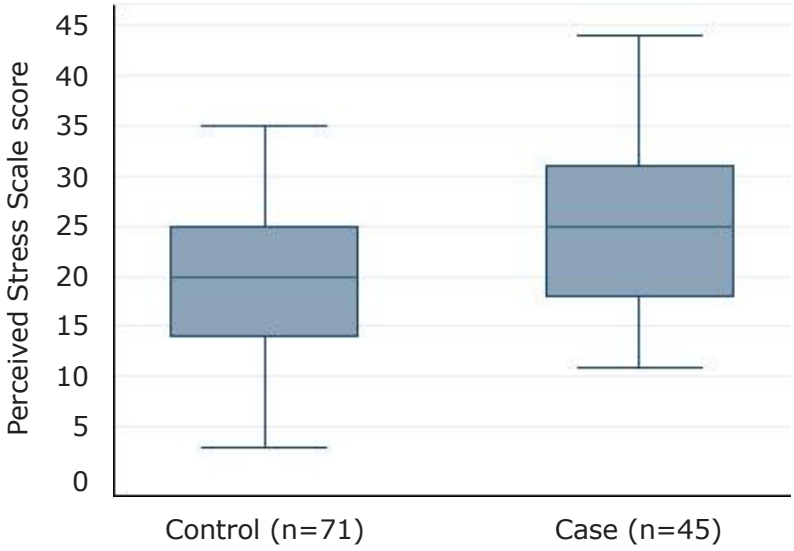
Results

Data were analyzed for 45 TMD cases and 71 controls after omitting 3 subjects whose cortisol concentrations exceeded 1,500 ng/g. The age of participants ranged from 18 to 59 years (mean=29.9 years) and the sample was predominantly female (80.2%) and Caucasian (84.2%).

TMD cases and controls did not differ on the basis of socio-demographic characteristics or smoking status. However, compared with controls, TMD cases perceived significantly higher levels of stress in their daily lives (p<0.001, Figure 1, Table I).

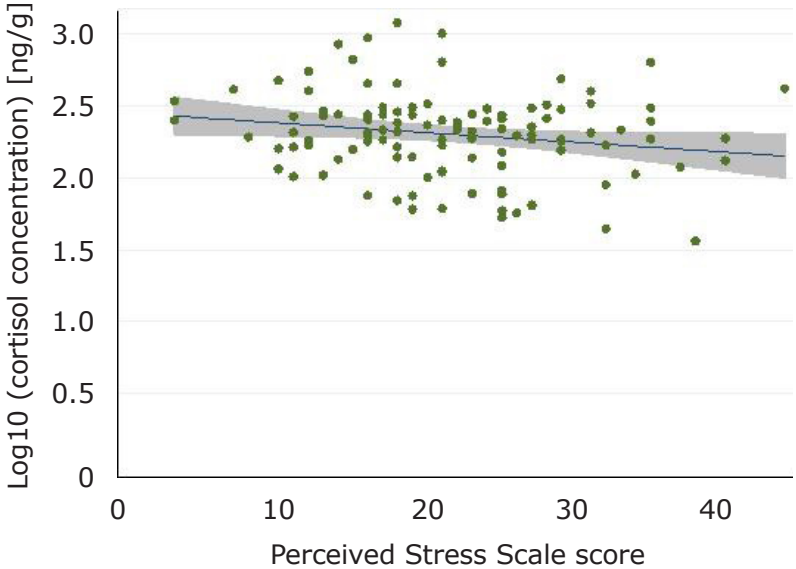
Perceptions of stress and levels of hair cortisol did not differ significantly between participants on the basis of age, sex, race, smoking or socioeconomic status (Table I). Despite perceiving higher levels of stress, cortisol concentrations were significantly lower in TMD cases than in controls (p<0.001).

Figure 1: Box and Whisker Plot of the Distribution of Perceived Stress Scores for TMD Controls and TMD Cases



The horizontal line within the box is the median value while the lower and upper hinges are the 25th percentile and 75th percentile, respectively. The ends of the whiskers represent the minimum and maximum values. A 2-group mean comparison t-test indicates the mean value for controls (19.7, s.e. 0.0) is statistically significant from that of cases (24.8, s.e. 1.2), p=0.0007.

Figure 2: Scatter Plot of the Relationship Between Perceived Stress Score (x-axis) and log10 Cortisol Concentration



(Y-axis) showing the fitted line and 95% confidence interval (n=116 observations). The Pearson correlation coefficient for this relationship is -0.188, p=0.044.

Examination of the cloud of observations on the scatter plot revealed a weak, negative relationship but statistically significant relationship between perceived stress and cortisol concentration (r=–0.188, p=0.044, Figure 2). When examined in separate strata of case status, the relationship was negative in each stratum, but failed to reach statistical significance for cases (r=–0.111, p=0.169) and controls (r=–0.082, p=0.498). Examination of the stratum-specific odds ratios and their confidence intervals

Table I: Distribution of Mean PSS Scores and Mean Log10 Hair Cortisol Concentration

	Perceived Stress score			Log10 cortisol concentration		
	Mean	SD	p-value	Mean	SD	p-value
TMD status						
Control	19.69	7.24	0.001	2.38	0.24	<0.001
Case	24.80	8.27	–	2.19	0.32	–
Sex						
Female	22.27	7.89	0.108	2.29	0.30	0.495
Male	19.26	8.25	–	2.34	0.26	–
Age group (years)						
<25	21.02	6.13	0.723	2.31	0.26	0.618
25-34	22.41	8.60	–	2.27	0.29	–
35-60	21.50	9.52	–	2.34	0.33	–
Race						
White	21.58	8.24	0.842	2.30	0.29	0.771
Not white	22.00	7.37	–	2.32	0.28	–
Educational attainment						
≤High school graduation	20.62	7.25	0.364	2.37	0.31	0.127
Some college or higher	22.11	8.32	–	2.28	0.28	–
Household income (USD)						
<$40,000	22.59	8.18	0.414	2.29	0.27	0.946
$40,000–<$100,000	21.11	8.77	–	2.31	0.27	–
≥$100,000	19.50	5.87	–	2.29	0.37	–
Smoking status						
Current	23.38	6.44	0.729	2.24	0.26	0.271
Former	20.65	10.05	–	2.40	0.32	–
Never	21.71	7.78	–	2.29	0.28	–

suggested that the relationship between perceived stress and hair cortisol concentration was similar in TMD cases and controls.

Discussion

Key Findings

In this study, TMD cases perceived significantly more stress than controls over the preceding 3 months, confirming a well-established relationship between psychosocial stress and TMD. Our expectation that higher stress perception in cases would correspond with elevated cortisol production was not supported. In fact, cortisol production was significantly lower in cases than controls. Among all subjects combined, perceived stress and cortisol concentration were significantly and negatively related, albeit in a weak relationship. When examined in stratum-specific analyses, perceived stress and cortisol concentration were negatively associated for both cases and controls, but non-significantly. In summary, individuals with higher perceived stress had lower hair cortisol concentration, and this effect was more pronounced among cases than controls.

Comparison with Previous Studies

This study is not the first to find an inverse or null association between perceived stress and hair cortisol concentration. A study that administered the PSS with a 3 month reference interval to university students reported a weak negative correlation with hair cortisol content (r=-0.061, p=0.025).[29] Another study compared long-term unemployed individuals with people in stable employment. The study found that the unemployed reported higher PSS scores, and the hair cortisol concentration was not associated with perceived stress.[30] Likewise, PSS scores and hair cortisol concentration were not associated among patients attending a cardiac rehabilitation program.[31] Elsewhere, a study comparing adults with severe chronic pain with healthy controls found a weak positive correlation between PSS scores and hair cortisol that failed to reach statistical significance (r=0.24, p=0.08, Spearman).[32] Similarly, the correlation between PSS scores and hair cortisol concentration was weakly positive but did not reach statistical significance (r=0.2, p=0.06) for subjects in a case control study where cases were patients with adrenal

insufficiency who were on hydrocortisone replacement therapy.[24] These findings differ from another conducted with pregnant women that reported a positive relationship between PSS scores and hair cortisol concentration.[33]

Few epidemiologic studies have measured hair cortisol in stress-related disorders. In these few studies, divergent findings report that cortisol is elevated in some disorders while lower in others. A pilot study compared hair cortisol concentration in severe chronic pain patients recruited from a chronic pain clinic who had received opioid treatment for at least 1 year (n=15), with pain-free control group recruited from the community (n=39). Perceived stress and cortisol levels were both higher in the opioid-treated chronic pain group with cortisol being almost elevated two-fold in the pain group (83.1 [33.0 to 204.9] pg/mg) relative to controls (46.1 [27.2 to 199.9] pg/mg).[32]

Consistent with findings from the severe chronic pain study, a study of men hospitalized following acute myocardial infarction found significantly higher median hair cortisol levels over the 3 months preceding the event (295.3 ng/g [105.4 to 809.3]) than hospitalized men admitted for other conditions (224.9 ng/g [76.58 to 949.9]).[34] By contrast to these 2 studies, in a case control study in which cases had generalized anxiety disorder, hair cortisol concentrations were 50 to 60% lower in cases than in healthy-age and sex-matched controls - a result that contradicted earlier research using short terms measures of cortisol.[35]

A study that might shed light on these differential patterns examined hair cortisol levels in female adolescents at multiple time points following the 2008 Wenchuan earthquake in China.[36] Subjects were classified into 1 of 3 groups: those who experienced the earthquake and developed posttraumatic stress disorder (PTSD), those who experienced the earthquake and did not develop PTSD and a group of non-PTSD controls from a different region that was unaffected by the earthquake. Hair segments corresponding to time before and several occasions after the earthquake were compared for cortisol concentration in all 3 groups. Hair cortisol concentrations were similar in all groups before the earthquake suggesting no difference in HPA axis activity at baseline. In the first 2 months following the earthquake, cortisol levels were significantly higher in both groups exposed to the earthquake compared with the control group. Then, at 2 to 4 months after the earthquake, and again at 5 to 7 months after the earthquake, the non-PTSD group exposed to the earthquake had significantly higher cortisol concentration than both the exposed PTSD group and the control group. The authors interpreted this as a blunted HPA response in the PTSD group.[36] The important finding was the change in cortisol secretion over time in the PTSD group from elevated initially, relative to controls, to suppressed.

Possible Mechanisms and Explanations

The noteworthy finding of the study of stress-responsive physiology to the earthquake is that timing since onset of chronic stress is important. It is possible that chronic stress elicits both an increased and a decreased production in cortisol, at different stages following onset of stress. In fact, this explanation was a major finding of a meta-analysis of 107 studies published between 1950 to 2005 that examined the relationship between chronic stress and HPA axis activity.[37] The meta-analysis concluded that exposure to chronic stress initially activates the HPA axis producing elevated secretion of cortisol. Over time HPA activity subsides and cortisol secretion rebounds to below normal levels.[37] The rebound may be a consequence of a cumulative stress burden. This is consistent with the concept of allostatic load that posits that overuse of systems designed to manage transient stress leads to impairment of the HPA function including a decrease in responsiveness to novel stressors and disturbance in the regulation of the key mediators.[38]

Applied to the present study, it is possible that prolonged or repeated perceptions of stress reported by TMD cases lead to blunted HPA activity and deficient cortisol signaling. In support of this idea are findings from a study of working women where high scores on the PSS were associated with an 11% attenuation in diurnal variation of salivary cortisol characterized as a pronounced reduction in cortisol awakening response.[39]

Strengths and Limitations

Strengths of the study relate to the rigor of the measurement protocols. The quantification of hair cortisol was conducted in laboratories in the Department of Physiology and Pharmacology, University of Western Ontario, an internationally prominent center for hair cortisol research. The Research Diagnostic Criteria for TMD case classification are standardized criteria that reliably ascertain TMD case classification. The PSS is widely used and has well established reliability and validity. Our findings are the first in the oral health literature to investigate hair cortisol as a systemic biomarker of long-term exposure stress. While our results did not support our hypothesis, the findings serve to

challenge an over-simplistic view of psychoneuroimmunology in TMD and other stress-related disorders.

There are several limitations to this study. Firstly, the expectation of a strong correlation between perceived stress and hair cortisol concentration rests on an erroneous assumption that these factors are 2 measures of the same phenomenon. However, one is a cognitive appraisal of stress and the other is the physiologic response to stress. Secondly, since information regarding the duration of TMD in the cases is not available, it was not possible to determine whether chronic cases were more likely than recent-onset cases to have a lower cortisol concentration. Information on other variables that may influence cortisol, such as alcohol use and body mass index, was not collected.

Implications for Dental Hygiene Practice

Psychosocial stress contributes to the etiology of several disorders that dental hygienists evaluate in clinical practice. Patients may be unaware that their orofacial muscle or joint pain has dental relevance. Likewise, the patient may not recognize that stress might be a contributing factor to their symptoms. Dental hygienists are well positioned to observe, discuss and evaluate potential TMD and its risk factors in the course of their intraoral and extraoral examinations. This is consistent with the American Dental Hygienists' Association Standards for Clinical Dental Hygiene Practice that hygienists perform an individualized assessment that includes interpretation of symptoms and clinical signs while systematically taking account of the general health status, history and needs of the patient.[40] In discussing the patient's oral status, the dental hygienist may inform the patient that stress is a common factor in TMD since this may be taken into consideration in formulating a patient-centered and evidence-based treatment plan.

This project was completed in partial fullfillment of the Masters of Science degree in Dental Hygiene Education at the University of North Carolina at Chapel Hill.

Conclusion

Measurement of hair cortisol in epidemiologic studies is still in its infancy and the mixed findings make interpretations difficult. Our understanding will be improved with prospective cohort studies that collect hair samples before and after first-onset of TMD.

Cynthia Ann Lambert, CDA, RDH, MS, is a clinical assistant professor at the Department of Dental Ecology, a clinical research coordinator at the Department of Operative Dentistry at the University of North Carolina School of Dentistry, Chapel Hill. Anne Sanders, MS, PhD, MS, is an assistant professor at the Department of Dental Ecology, School of Dentistry, University of North Carolina at Chapel Hill. Rebecca S. Wilder, BSDH, MS, is a professor, Director of Faculty Development and Director of Graduate Dental Hygiene Education at the University of North Carolina School of Dentistry. Gary D. Slade, BDSc, DDPH, PhD, is a John W. Stamm Distinguished Professor of Dentistry, Department of Dental Ecology at the UNC School of Dentistry, Chapel Hill. Stan Van Uum, MD, PhD, FRCPC, is the Program Director of Endocrinology and Metabolism and Associate Professor of Endocrinology & Metabolism at the Department of Medicine, Western University, London, Ontario. Evan Russell MSc, is affiliated with the University of Toronto, Western University. Gideon Koren MD, FRCPC, FACMT, is the Director of the Motherisk Program at the Hospital for Sick Children, Professor of Pediatrics, Pharmacology, Pharmacy and Medical Genetics at the University of Toronto and a Professor of Medicine, Pediatrics and Physiology/Pharmacology at the Ivey Chair in Molecular Toxicology at the University of Western Ontario. William Maixner, DDS, PhD, is a Mary Lily Kenan Flagler Bingham Distinguished Professor and Director, Regional Center for Neurosensory Disorders, University of North Carolina at Chapel Hill.

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Diabetes-Related Knowledge and Sources of Information among Periodontal Patients: Is There a Role for Dental Hygienists?

Shiela M. Strauss, PhD; Geetika Singh, BDS; Janet Tuthill, RDH, MA; Anya Brodsky, DDS; Mary Rosedale, PhD; Ariana Bytyci, BS, RDH; Inna Drayluk, MA; Alisa Llambiri, AAS; Krystal Savice, BS; Stefanie Russell, PhD, MPH, DDS

Introduction

A considerable body of research has found a relationship between periodontal disease and diabetes. For example, in 2007, a panel of experts representing academic, research and clinical medicine and dentistry performed a systematic review of the literature concerning diabetes and periodontal disease.[1] They concluded that diabetes can affect the periodontium and that periodontitis is an important complication of diabetes.[1] In their meta-analysis in 2006, Khader et al concluded that while persons with and without diabetes had the same extent of periodontal disease, persons with diabetes had significantly higher severity of disease.[2] Other meta-analyses have suggested that periodontal treatment may lead to some improvement in glycemic control in persons with diabetes.[3-5] In addition, Strauss et al analyzed diabetes and periodontal disease data collected in the 2003 to 2004 National Health and Nutrition Examination Survey (NHANES).[6] They found that among individuals with moderate or severe periodontal disease who reported never having been diagnosed with diabetes, 93% met American Diabetes Association criteria for diabetes risk and would have been recommended for diabetes screening according to the American Diabetes Association's guidelines.[6] In view of the many individuals with undiagnosed diabetes,[7] the increased risk for diabetes among persons with periodontal disease[6] and the fact that some persons with periodontal disease might not be screened for

Abstract

Purpose: Although there is a bidirectional relationship between periodontal disease and diabetes, little is known about the diabetes-related knowledge of periodontal patients. This study examines what patients with periodontal disease know about diabetes and its association with periodontitis. It also examines their sources of diabetes-related information.

Methods: Patients (n=111) with or at risk for diabetes who were receiving care at a university-based periodontics and implant clinic completed a written survey assessing their sociodemographic characteristics, health-related activities, diabetes knowledge and sources of diabetes-related information. Survey results were summarized using descriptive statistics. Fisher's exact tests were used to compare patients who had and had not been diagnosed with diabetes according to responses on diabetes-related knowledge items and sources of diabetes information.

Results: Although respondents endorsed various diabetes-related information sources, including family and friends and health care providers, respondents demonstrated very limited knowledge about the diabetes and periodontal disease association. There were no statistically significant differences between patients who had, and had not been diagnosed with diabetes regarding their diabetes-related knowledge. As compared with patients not diagnosed with diabetes, patients with diabetes were significantly more likely to have learned about diabetes from a health care provider (p=0.05) and significantly less likely to have learned about it from friends or family (p=0.05).

Conclusion: Periodontal patients need education about the periodontitis-diabetes relationship. Dental hygienists' regular and ongoing involvement with these patients and their primary role in the patients' periodontal care places them in an optimal position to provide this education.

Keywords: Periodontal disease, Diabetes mellitus, Educational assessment; Dental hygienists

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

diabetes because they do not have regular contact with a primary care provider,[8] the dental visit may be an especially important setting for opportunistic diabetes screening. For patients already diagnosed with diabetes, monitoring the extent to which their diabetes is under control can help dental professionals make decisions about optimal treatment for oral health care.[9]

A variety of approaches can be used to screen for diabetes at dental visits. One approach involves the use of oral and demographic data to identify patients who are at risk.[10-12] Another involves using a hand-held glucose meter to perform chairside glucose testing using finger stick or gingival crevicular blood, the latter obtained from patients with periodontitis.[13-17] Yet another approach involves the chairside collection of a sample of periodontal patients' finger stick or gingival crevicular blood placed on filter paper.[18] The blood sample is then allowed to dry and sent to a laboratory for testing of hemoglobin A1c (HbA1c).[18] The HbA1c test has recently been promoted by the American Diabetes Association as a test for diabetes diagnostic purposes.[19]

Some dental providers have, in fact, expressed their willingness to conduct chairside screenings for medical conditions, including diabetes.[20] However, dental chairside screenings also require dental patients' willingness to participate.[21] Such willingness will likely require that patients have knowledge about diabetes and its association with periodontal disease. There has been some research in the U.S. and elsewhere examining diabetes patients' knowledge about periodontal disease as a complication of diabetes. This knowledge has been shown to be limited.[22-28] For example, in a U.S. study, 30% of 253 individuals with diabetes did not know that people with diabetes are more likely to have gum disease and that diabetes could make the condition of one's teeth and gums worse.[22] Another U.S. study involving 390 patients with diabetes found that only 18.2% recognized that their oral health might be affected by diabetes.[28] In addition, a study of 405 patients with diabetes in Jordan determined that 47.7% were aware that diabetes patients were prone to gum disease and oral health complications and 38% knew that periodontal treatment may help in controlling diabetes.[27] A study of 240 diabetic patients in Pakistan found that 35.4% knew that an individual with diabetes was more prone to oral diseases and 38% knew that smoking is more injurious to the gums of a person with diabetes than to a person without diabetes.[23] The studies that examined diabetes patients' sources of information regarding the link between diabetes and oral health identified these sources as including dentists, dental hygienists, physicians, nurses, the internet and television.[25,27] To our knowledge, no study has examined periodontal patients' knowledge about diabetes and its association with periodontitis and diabetes or the sources of their diabetes-related information.

To the extent that there may be gaps in knowledge about the periodontitis-diabetes relationship among periodontal patients, even patients who have regular contact with medical primary care providers may not have their knowledge gaps filled by these providers. Many medical providers have limited familiarity with the link between diabetes and periodontal disease.[29] However, dental hygienists are in a unique position to educate their patients and to reinforce diabetes-related knowledge. This is especially the case due to their regular involvement with periodontal patients who are seen several times each year for periodontal maintenance and their knowledge about the oral-systemic link. This knowledge is reflected in survey responses of 392 dental hygienists in 2008 that indicate that about 90% knew that periodontal disease is considered a complication of diabetes and that periodontal disease may worsen glycemic control, with 90.1% of the surveyed dental hygienists reporting feeling competent in educating patients about oral health and diabetes.[30] In addition, a 2007 survey of 134 U.S. dental hygiene program directors found that most dental hygiene students were assessed (and therefore needed to show competence) in their knowledge of the periodontal-diabetes association.[31] For example, 90% of dental hygiene students were assessed on their ability to discover patients' potential for periodontal-diabetes complications and 92% for discussing the risk of these complications with patients. Research has also found that many dental hygienists currently provide information and educational materials to diabetes patients about periodontal disease and oral health.[30]

This study examined current knowledge about diabetes and sources of diabetes-related information among periodontal patients with diabetes and periodontal patients at risk for diabetes in order to better understand their diabetes-related information needs.

Methods and Materials

Participant recruitment and data collection took place at the New York University (NYU) College of Dentistry Periodontics and Implant Clinic from March through May 2011. Prospective participants were involved in a study whose primary focus was to examine the acceptability and feasibility of using a novel intra-oral chairside diabetes screening approach.[18] To be included, periodontal patients needed to be at least 18 years of age and either have diabetes or be at risk for diabetes according to criteria established

by the American Diabetes Association.[32] Consistent with NHANES exclusion criteria, patients were ineligible to participate in the research if they required antibiotic pre-medication before dental treatment or if they had a history of severe cardiovascular, hepatic, immunological, renal, hematological or other organ impairment.[33] Individuals were assured that the decision regarding participation would not affect services they received at the NYU College of Dentistry. The institutional review board at the NYU School of Medicine approved all survey instruments and procedures.

After participants gave their informed consent for study participation, a research assistant monitored completion of a 5 minute eligibility assessment that determined self-reported diabetes status and elements of diabetes risk according to the American Diabetes Association (e.g., older age, high body mass index, amount of exercise during a given day, diabetes in a first degree relative, minority ethnicity/race).[32] Participants completed a 10 minute written survey while waiting for their dental visit at the NYU College of Dentistry Periodontics and Implant Clinic. The survey gathered socio-demographic information not collected on the eligibility assessment (e.g., sex, education), participants' health related activities (regularity of visits with a dental provider, past testing for blood glucose) and assessed participants' knowledge about diabetes and their sources of diabetes-related information.

The Diabetes Knowledge Assessment and Sources of Diabetes-Related Information

The 10-item Diabetes Knowledge Assessment was developed by members of the project team using fact sheets from the National Institute of Dental and Craniofacial Research, the Centers for Disease Control and Prevention, the American Diabetes Association, the American Academy of Periodontology and the National Diabetes Information Clearinghouse,[7,34-37] a report from the American Diabetes Association[38] and a review of the literature on diabetes and periodontal disease. Before pilot testing the assessment with 51 periodontal patients who participated in an earlier research study at the NYU College of Dentistry Periodontics and Implant Clinic,[13] it was reviewed for appropriate wording and face validity by NYU colleagues with expertise in diabetes and periodontology. Detailed review of the assessment items with 5 of the study participants suggested addition of a "don't know" option for 8 of the 10 questions.

The Diabetes Knowledge Assessment contained 2 components: a General Diabetes Component (6 items) and a Periodontal-Diabetes Association Component (4 items). The General Diabetes Component included items concerning the effect of diabetes on blood sugar, diabetes diet, types of diabetes, awareness of diabetes status, causes of diabetes and high blood glucose levels. The Periodontal-Diabetes Association Component contained questions concerning the periodontitis-diabetes connection and its relationship to smoking and to blood glucose levels. The first 2 items in the General Diabetes Component were multiple-choice type questions with 2 answer options. Each of the remaining items (4 questions) in the General Diabetes Component and all items in the Periodontal-Diabetes Association Component (4 questions) were true/false type questions along with a "don't know" option.

Participants also responded to questions regarding sources of diabetes information (a health care provider, friends or family, school, newspapers, magazines or books, television, or the internet).

Statistical Analysis

Descriptive statistics were used to report results on the Diabetes Knowledge Assessment, participants' socio-demographic characteristics and health-related factors, and sources of diabetes-related information. Fisher's exact tests were used to compare patients who reported that they had and had not been diagnosed with diabetes according to responses on diabetes-related knowledge and sources of diabetes-related information. All analyses were conducted using Predictive Analytics Software version 18.0.

Results

Characteristics of the Participants

Of the participants who completed the Diabetes Knowledge Assessment (n=111), 56.8% were female. Participants ranged in age from 23 to 87 years, with an average age of 56.6 years (SD=13.7). With regard to their ethnicity, 22.7% were Latino. A total of 37.3% were Black, African American or Caribbean, 40.0% were Caucasian and 7.3% were Asian, Native American, American Indian or Pacific Islander. All but 4 of the remaining 17 participants identified their race as Hispanic. Most (74.3%) had at least some college education. More than half of the respondents (58.6%) had a body mass index (BMI) >25 kg/m2 and 48.6% indicated little daily exercise. A total of 80.2% saw a health care provider in the past year, with 84.3% of these participants indicating that they had a test for blood glucose in the past. In all, 79% of all 111 participants indicated that they had had a past test for blood glucose and 19.8% indicated that they had been told by a

Table I: Responses on the General Diabetes Component of the Diabetes Knowledge Assessment (%) (n=111)

Item	Told Have Diabetes (n=22)		Not Told Have Diabetes (n=89)		All Participants (n=111)	
	Choice A	Choice B	Choice A	Choice B	Choice A	Choice B
The diabetes diet is: (a) A healthy diet for most people (b) Too high in protein for most people	86.4*	13.6	88.8*	11.2	88.3*	11.7
Diabetes causes your: (a) Blood sugar to be too high (b) Body to stop making blood sugar	100.0*	0.0	84.3*	15.7	87.4*	12.6

Item	Told Have Diabetes (n=22)			Not Told Have Diabetes (n=89)			All Participants (n=111)		
	True	False	Don't Know	True	False	Don't Know	True	False	Don't Know
There is just one type of diabetes	4.5	81.8*	13.6	3.4	83.1*	13.5	3.6	82.9*	13.5
Just about everyone who has diabetes knows that they have it	13.6	81.8*	4.5	2.2	83.1*	14.6	4.5	82.9*	12.6
A fasting blood sugar level of 250 is too high	72.7*	0.0	27.3	56.2*	2.2	41.6	59.5*	1.8	38.7
Eating too many sweet foods is one cause of diabetes	59.1	27.3*	13.6	56.2	24.7*	19.1	56.8	25.2*	18.0

*Correct Response

health care provider that they had diabetes. Almost half (45.9%) reported a first degree relative (i.e., a parent or sibling) who had diabetes. Most (78.7%) indicated that they had dental checkups at least annually with a dentist or dental hygienist.

Diabetes Knowledge Assessment

General Diabetes Component: As seen in Table I, more than 80% of the participants responded correctly to questions regarding the diabetes diet, effect of diabetes on blood sugar, the number of types of diabetes and the many people unaware that they have diabetes.[7,35,38] However, only 59.5% (n=66) could correctly identify a high blood glucose level.[7] Moreover, only 25.2% (n=28) knew that eating too many sweet foods did not cause diabetes.[35] There were no statistically significant differences between patients who had, and had not been diagnosed with diabetes according to their responses on any of the items on the General Diabetes Component ($p>0.05$).

Periodontal-Diabetes Association Component: As can be seen in Table II, only 39.6% (n=44) knew that "people with diabetes have gum problems more often if their blood sugar stays very high," and only 23.4% (n=26) knew that "if you have gum disease, it is likely to be harder to control your blood sugar."[36] In addition, only 17.1% (n=19) knew that people with diabetes who smoke are more likely to "get a bad case of gum disease" than those with diabetes who don't smoke,[34] and only 11.7% (n=13) knew that people with diabetes are more likely to have periodontal disease than those without diabetes.[37] The proportion of people who selected "don't know" regarding the association between periodontal disease and diabetes ranged from 45.0% to 61.3% (n=50 to n=68) on each of the items. There were no statistically significant differences between patients who had and had not been diagnosed with diabetes according to their responses on any of the items on the Periodontal-Diabetes Association Component ($p>0.05$).

Sources of Diabetes-Related Information

A total of 109 of the 111 participants who completed the Diabetes Knowledge Assessment selected 1 or more of the provided options in describing how they had learned about diabetes. As can be seen in Table III, more than half of the participants had learned about diabetes from friends or family. Some got their information from a health care provider (38.5%), print materials (36.7%) or television (30.3%). A smaller proportion of participants learned about diabetes from the internet (20.2%) or from school (13.8%). Patients who had been di-

Table II: Responses on the Periodontal-Diabetes Association Component of the Diabetes Knowledge Assessment (%) (n=111)

Item	Told Have Diabetes (n=22)			Not Told Have Diabetes (n=89)			All Participants (n=111		
	True	False	Don't Know	True	False	Don't Know	True	False	Don't Know
People with diabetes have gum problems more often if their blood sugar stays very high	50.0*	4.5	45.5	37.1*	6.7	56.2	39.6*	6.3	54.1
If you have gum disease, it is likely to be harder to control your blood sugar	18.2*	18.2	63.6	24.7*	14.6	60.7	23.4*	15.3	61.3
For people with diabetes, those who smoke cigarettes get a bad case of gum disease about as often as those who don't smoke	50.0	9.1*	40.9	29.2	19.1*	51.7	33.3	17.1*	49.5
People with diabetes are just as likely to get gum disease as people who don't have diabetes	59.1	9.1*	31.8	39.3	12.4*	48.3	43.2	11.7*	45.0

*Correct Response

agnosed with diabetes were significantly more likely than patients who had not been diagnosed with the condition to have learned about diabetes from a health care provider (59.1% vs. 33.3%, respectively, p=0.05) and were significantly less likely to have learned about diabetes from friends or family (36.4% vs. 60.9%, respectively, p=0.05).

Table III: Participants' Sources of Diabetes-Related Information (%) (n=109)

Source	Told Have Diabetes (n=22)	Not Told Have Diabetes (n=87)	All Participants (n=109)
Friends or family[a]	36.4	60.9	56.0
Health care provider[b]	59.1	33.3	38.5
Newspapers, magazines, or books	31.8	37.9	36.7
Television	27.3	31.0	30.3
Internet	22.7	19.5	20.2
School	13.6	13.8	13.8

[a]p=.05
[b]p=.05

Discussion

Results indicate that this convenience sample of periodontal patients had greater knowledge about general diabetes issues than they did about the association between periodontal disease and diabetes. Given the high correlation between periodontitis and diabetes, it is concerning that correct responses to each of the 4 survey items on this association were endorsed by fewer than half of the participants, with a large percentage indicating that they did not know if these diabetes knowledge statements were true or false. Thus, both periodontal patients and diabetes patients have limitations in knowledge about the periodontal-diabetes link.[22-28]

Results suggest that participants had considerable exposure to general information about diabetes. Friends and family were a frequent source of this information, especially for participants without diabetes. While health care providers were the most frequent source of this information for those who had been told they had diabetes, 79% indicated having had a test for blood glucose. Therefore, it is not surprising that a large minority of those who had never been told that they had diabetes also reported they had learned about diabetes from health care providers. However, because internists and endocrinologists may not have much specific knowledge about the relationship between diabetes and periodontal disease,[29] they may not have made the periodontal-diabetes association known to their patients. Whether learning about diabetes from family or friends, health care providers, printed material, television, the internet or school (similar sources of information for diabetes patients regarding periodontal disease[25,27]), it is clear that the study sam-

ple's knowledge about the association between periodontal disease and diabetes is limited.

Dental hygienists are in a unique position to educate and periodically review information with periodontal patients about the oral-systemic disease connection, including mechanisms underlying the association between diabetes and periodontal disease, and they could also help patients to evaluate their own diabetes risk. In particular, dental hygienists can provide periodontal patients with disease prevention information, counsel patients with diabetes to maintain good glycemic control and collaborate with and/or refer patients to other health care providers. Many dental hygienists see their periodontal patients on a regular basis, and they are the primary professionals in periodontal practice charged with providing non-surgical periodontal care.[39]

Regarding dental hygienists' knowledge about diabetes, Boyd et al's 2008 survey findings indicated that participating dental hygienists' diabetes and oral health knowledge was relatively up-to-date,[30] and Wilder et al's 2007 survey of U.S. dental hygiene program directors indicated that dental hygienists were knowledgeable about diabetes and that they were assessed for their diabetes-related competencies.[31] However, many dental hygiene programs do not provide extensive diabetes education. For example, Wilder et al's survey found that 30.8% of 138 dental hygiene program directors reported fewer than 3 didactic hours of teaching about the periodontal-diabetes connection.[31] In addition, Boyd et al reported that 75% of the 392 participants in their nationwide survey of dental hygienists indicated that they had 4 or fewer hours of diabetes education in their entry level dental hygiene programs.[30] Only 50.4% of the surveyed dental hygienists had completed more than 4 hours of continuing professional education related to diabetes since graduation from their professional programs.[30] Information about diabetes changes rapidly. Thus, in order for dental hygienists to be able to optimally inform and educate their patients about diabetes and its relationship to periodontal disease, they need more entry-level diabetes content and continuing education. This is of particular importance because patients do not appear to be obtaining this information elsewhere.

A limitation of this research is that the results were obtained using data from a non-random convenience sample of periodontal patients from 1 university-based periodontal clinic. As such, it is unclear to what extent the results are representative of periodontal patients in this or other university-based clinics or in periodontal practice settings in diverse geographic locations. Additional research could focus on assessing periodontal patients' diabetes-related knowledge in a variety of locations and practices.

Conclusion

In spite of its limitations, this study suggests that knowledge about diabetes and its association with periodontal disease may be limited among periodontal patients. These results support the need for education about the periodontitis-diabetes relationship for these at-risk patients. In view of dental hygienists' regular and ongoing involvement with periodontal patients, their knowledge about the periodontal-diabetes association and their primary role in patients' periodontal care, they are in an optimal position to provide patients with comprehensive and accurate information to best maintain their health.

Shiela M. Strauss, PhD, is an associate professor at the NYU College of Nursing. Geetika Singh, BDS, was a research scientist at the Department of Epidemiology and Health Promotion, NYU College of Dentistry. Janet Tuthill, RDH, MA, is director of the Dental Assisting Program, Stony Brook University, School of Dental Medicine, and Clinical Assistant Professor at the NYU College of Dentistry, Dental Hygiene Program. Mary Rosedale, PhD, APRN-BC, is an assistant professor at the NYU College of Nursing. Stefanie L. Russell, PhD, MPH, DDS, is an associate professor, Department of Epidemiology & Health Promotion, NYU College of Dentistry. Inna Drayluk, MA, is currently employed at Madison Dental Partners, New York. Anya Brodsky, DDS, is with Yale New Haven Hospital. Ariana Bytyci, BS, RDH, is currently working as a dental hygienist in Prishtina, Kosovo. Alisa Llambiri, AAS, is currently working in a private practice in New York. Krystal Savice, BS, is currently employed at the Family Dental Group in New York.

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Setting and Validating the Pass/Fail Score for the NBDHE

Tsung-Hsun Tsai, PhD; Barbara Leatherman Dixon, RDH, BS, MEd

Abstract

Purpose: This report describes the overall process used for setting the pass/fail score for the National Board Dental Hygiene Examination (NBDHE).

Methods: The Objective Standard Setting (OSS) method was used for setting the pass/fail score for the NBDHE. The OSS method requires a panel of experts to determine the criterion items and proportion of these items that minimally competent candidates would answer correctly, the percentage of mastery and the confidence level of the error band. A panel of 11 experts was selected by the Joint Commission on National Dental Examinations (Joint Commission). Panel members represented geographic distribution across the U.S. and had the following characteristics: full-time dental hygiene practitioners with experience in areas of preventive, periodontal, geriatric and special needs care, and full-time dental hygiene educators with experience in areas of scientific basis for dental hygiene practice, provision of clinical dental hygiene services and community health/research principles. Utilizing the expert panel's judgments, the pass/fail score was set and then the score scale was established using the Rasch measurement model.

Results: Statistical and psychometric analysis shows the actual failure rate and the OSS failure rate are reasonably consistent (2.4% vs. 2.8%). The analysis also showed the lowest error of measurement, an index of the precision at the pass/fail score point and that the highest reliability (0.97) are achieved at the pass/fail score point.

Conclusion: The pass/fail score is a valid guide for making decisions about candidates for dental hygiene licensure. This new standard was reviewed and approved by the Joint Commission and was implemented beginning in 2011.

Keywords: validity, Objective Standard Setting method, pass/fail score, NBDHE

This study supports the NDHRA priority area, **Professional Education and Developme:** Critically appraise current methods of evaluating clinical competency.

Introduction

In examinations used for making decisions about candidates for licensure purposes, candidates' levels of achievement on the examinations are classified into "pass" if the scores are at or above the established pass/fail score, and "fail" if the scores are below the established pass/fail score. Deriving psychometric and legally defensible pass/fail scores is important to identify minimal competency of the candidate, thereby assisting state boards in making valid decisions regarding licensure and providing protection to the public from unqualified candidates.[1-5] The Standards for Educational and Psychological Testing also suggest a pass/fail score for a licensing examination be set appropriately to ensure the results of the assessment are valid.[6] In response to these recommendations, the Joint Commission on National Dental Examinations (Joint Commission), the agency responsible for developing, administering, scoring and reporting the National Board Dental Hygiene Examination (NBDHE) results, conducted a standard setting to set the pass/fail score for the NBDHE to accurately classify passing and failing candidates. As an essential part of providing the validity evidence to communities of interest who use the results of the NBDHE for making decisions, it is important that the Joint Commission reports the process for setting and validating the pass/fail score for the NBDHE in a professional journal. The purpose of this report is to fulfill this responsibility by describing the overall process used for setting the pass/fail score for the NBDHE.

The National Board Dental Hygiene Examination[7]

The NBDHE is designed to assist state boards in assessing the qualifications of individuals who seek licensure to practice dental hygiene. The examination is typically taken by student candidates during the last year of the dental hygiene program. The NBDHE assesses the candidate's ability to understand important information from basic biomedical, dental and dental hygiene sciences and the ability to apply such information in a problem-solving context. This comprehensive, computer-based examination consists of 350 multiple-choice items covering 3 major areas for 13 disciplines (Table I). Items are balanced within multiple disciplines from which the

items are sampled. Items are presented with a stem pairing a question or statement with a list of 4 or 5 possible responses. The examination includes 200 discipline-based items and 150 items based on 12 to 15 dental hygiene patient cases. Each case presented in the examination consists of patient histories, dental charts, diagnostic radiographs and clinical photographs.

Selection of the Panelists

The guidelines from the Standards for Educational and Psychological Testing were used in the selection of a panel of the NBDHE experts.[6] The Joint Commission reviewed and approved the following selection criteria:

- Full-time practicing dental hygienists with experience in areas of preventive, periodontal, geriatric and special needs care
- Full-time dental hygiene educators with experience in areas of scientific basis for dental hygiene practice, provision of clinical dental hygiene services and community health/research principles
  - Geographic distribution with both urban and rural representation from major regions of the U.S. by ensuring demographic diversity (gender, age, race, ethnicity, etc.)

The Joint Commission sent a call for nominations to all communities of interest and then reviewed all nominees' credentials. Of the nominees, 11 individuals (10 dental hygienists and 1 dentist) were selected. The Joint Commission determined that these experienced clinicians and educators represented expertise in all areas of content in the NBDHE and that their judgments would characterize the dental hygiene profession's estimation of what the new or entry level dental hygienist should know and do.

Methods and Materials

The standard setting was conducted using the Objective Standard Setting method (OSS).[8] Onsite training was provided to panelists at the meeting. First, the panelists' role and responsibilities were clarified. Second, the background and purpose of the NBDHE were presented. Third, the meeting materials, including the standard setting protocol which was developed by the Joint Commission providing detailed information regarding the concept and the use of the OSS method, the NBDHE content specifications and sample questions from the NBDHE, were reviewed. Fourth, the overall process involved in validating the pass/fail score for the NBDHE was presented. In addition, to help the panelists conceptualize and correctly use the OSS method, sample items from the NBDHE were used. During the practice training process, each panelist rated each sample item individually by judging its importance to patient care using a rating scale ranging from 1 to 5, with 1 indicating very unimportant to patient care and 5 indicating critically important to patient care. After the ratings were complete, the group was asked if there were any specific problems or issues fundamental to rating the item. Concerns or issues were then addressed and discussed. Based on the group discussion, panelists were given the opportunity to change their ratings if they wanted. Once the discussion and revisions were done, the group moved on to the next sample item. This process repeated until the panelists understood the concept and felt comfortable applying the principles to the actual activities.

Table I: Major Areas in the NBDHE

Major Area (3)	Discipline (13)
Scientific Basis for Dental Hygiene Practice	• Anatomic Science • Physiology, Biochemistry and Nutrition • Microbiology and Immunology • Pathology • Pharmacology
Provision of Clinical Dental Hygiene Services	• Patient Management • Radiology • Management of Dental Hygiene Care • Periodontology • Preventive Agents • Supportive Treatment • Professional Responsibility
Community Health/ Research Principles	• Community Health

The OSS method requires panelists to make 3 recommendations:

- Selection of criterion items and proportion of these items that minimally competent candidates would answer correctly
- Determination of the percentage of mastery
- Determination of the confidence level

Each panelist selected items that they considered to be very important using the following criteria:

- The content of criterion items must be central, or directly related, to practice
- Criterion items must assess the knowledge and problem-solving skills that are utilized frequently in practice
- Criterion items must assess the knowledge and problem-solving skills that are dynamic and subject to change with current research and development in the field

Table II: Comparison of Actual vs. the OSS Results

Examination	Actual		OSS	
NBDHE	Number of Failing Candidates	Percent failing	Number of Failing Candidates	Percent failing
n=4,528	108	2.4%	129	2.8%

- The content of the criterion items must be of fundamental and critical importance to successful practice
- The content of the criterion items must assess the minimum knowledge and problem-solving skills that are to have been acquired by the candidate
- Criterion items must be selected from throughout the examination
- Criterion items must be selected from a full range of the content included on the examination

The next task was related to the level of mastery. The panelists were instructed to record their estimates for an acceptable level of mastery (0 to 100%) necessary to pass the NBDHE. This estimate was based on the panelists' knowledge of the reference group and the content sampled by the examination. The reference group consists of all students who are currently enrolled in accredited dental hygiene programs and who are taking the examination for the first time.

Finally, judgments regarding the extent of error were necessary to complete the standard-setting activities. The panelists recorded their estimates as to how large the error band around a score should be. The notion of error is involved in measuring the performance of candidates. The true score of a candidate is somewhere within an error band. When a candidate's score falls within the error band around the standard, the score could be evaluated as a passing or failing score. There are several options to consider. If the emphasis is protection of the public, one would pass only candidates whose scores exceed the upper limit of the error band. At the other end of the spectrum, if the focus is on protecting the innocent candidate, all candidates whose scores exceed the lower limit of the error band would pass. A 95% confidence level is considered appropriate.[9] From the independent judgments of the panelists, the estimate fell within this suggested appropriate error band.

Results

Based on the panelists' judgments, the NBDHE pass/fail score was set using the OSS method. The score scale was then established using the Rasch model.[10] In the Rasch model, candidate ability and item difficulty are described by a single measurement scale. This means that candidate ability can be directly related to the specific abilities, knowledge and problem solving skills that underlie items on the NBDHE. The candidate's ability is estimated based on the probability of a right or wrong response on each item. The underlying ability scale is centered at 0 and typically ranges from a -5.00 to a 5.00, with more negative values indicating relatively easier items and lower-scoring candidates. In like manner, more positive values indicate relatively more difficult items and higher-scoring candidates. Because candidate ability and item difficulty are on the same scale, it is possible to directly relate the 2 statistics relative to the criterion items. According to the judgments of the panelists, the knowledge underlying the criterion items is critically important to patient care. The pass/fail score was derived by the average difficulty of the criterion items in concert with the error band and the percentage of mastery suggested by the panelists. Those candidates whose scores were at or above this pass/fail point would pass. This point along the measurement scale is assigned a standard score of 75.

After the pass/fail score was determined, the abilities of candidates were estimated for every possible raw score (number of correct responses), ranging from 0 to 350. Score conversions were developed to translate raw scores into standard scores for all exam forms using the common-item equating design.[11]

Discussion

Among various criteria available to evaluate the appropriateness of the pass/fail score produced by the panelists' judgments using the OSS method, one major criterion used by the Joint Commission was to examine the consistency of the failure rates between what actually happened and the results produced by the OSS method. To meet this objective, a statistical analysis was conducted to compute the following statistics. The data were based on the 4,528 candidates taking the March 2009 edition of the NBDHE:

- The actual percentage of failing candidates
- The percentage of failing candidates using the results from the OSS method

Table II presents the comparison of failure rates between what actually happened and the panelists' results using the OSS method. As shown, of the 4,528 candidates taking the March 2009 edition of the NB-

DHE, 108 (2.40%) failed. If the panelists' judgments had been employed as the minimum passing score, 129 (2.8%) would have failed. Comparison of actual versus the OSS failure rates shows little change.

In addition, a psychometric analysis was conducted to examine the precision at the pass/fail score derived by the OSS method. Results show that the error of measurement at the pass/fail score point on the measurement scale is the lowest. In other words, maximum reliability (0.97) is achieved at the pass/fail score point.

Conclusion

A statistical analysis and a psychometric analysis were conducted to verify the appropriateness of the pass/fail score derived by the OSS method. The results of the analyses show that the actual failure rate and the failure rate derived by the OSS method are reasonably consistent. The error of measurement is lowest and the reliability is highest at the pass/fail score point on the measurement scale. Results of the standard-setting activities support the conclusion that the pass/fail score on the NBDHE is a valid guide for making decisions about candidates who seek licensure to practice dental hygiene.

When scores on an examination are used as a basis for making high stakes pass/fail decisions, it is necessary to validate the cut score that separates passing and failing candidates.[6] This report provides psychometrically sound process, analyses and guidelines to set and validate the pass/fail score for making decisions about candidates for dental hygiene licensure.

Tsung-Hsun Tsai, PhD, is a research consultant in educational measurement and testing. Barbara Dixon, RDH, BS, MEd, is a dental hygienist with over 30 years experience in clinical practice and education.

Disclaimer

The information and opinions contained in this article reflect and are solely the work of the authors and are not those of the American Dental Association or its employees or members.

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Influence of Continuing Education on Dental Hygienists' Knowledge and Behavior Related to Oral Cancer Screening and Tobacco Cessation

Margaret M. Walsh, RDH, MS, MA, EdD; Kathleen V. Rankin, DDS; Sol Silverman Jr, MA, DDS

Abstract

Purpose: There are more than 35,000 new cases of oral and pharyngeal cancers (OPC) diagnosed each year. Most OPCs are diagnosed in advanced stages, requiring aggressive treatment and resulting in higher morbidity and mortality than when diagnosed early. The overall 5 year survival rate of OPC is about 60%. Early detection of OPC lesions are the key to survival. A major risk factor for OPC is chronic tobacco use. The purpose of this paper is to report changes in dental hygienists' knowledge, attitudes and behaviors 6 months after attending a standardized lecture format continuing education (CE) course on early OPC detection and tobacco cessation counseling compared to baseline values.

Methods: A total of 64 CE courses were given for dental professionals throughout the 10 U.S. public health districts to determine if OPC screenings and tobacco cessation counseling behaviors could be modified at 6 months post-training. Questionnaires were obtained at baseline and 6 months later using a pre-/post-test design.

Results: A total of 1,463 dental hygienists participated at baseline and 543 at a 6 month follow-up. Data showed a significant difference in knowledge and behavior compared to baseline values.

Conclusion: CE appeared to have a significant influence on participants' OPC and tobacco cessation knowledge and behavior, and could potentially make a difference on prevention, early detection and ultimately on OPC control.

Keywords: Oropharyngeal cancer, tobacco cessation, dental hygienists, continuing education

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

Introduction

There are more than 35,000 new cases of oral and pharyngeal cancers (OPC) diagnosed each year.[1] OPC includes cancers of the lip, tongue, floor of mouth, oral cavity, tonsils, oropharynx and pharynx. Approximately 90% are squamous cell carcinomas. The most common intraoral sites for squamous cell carcinoma are the tongue, the floor of the mouth and oropharynx.[1]

Early signs of OPC include erythroplakia (red patches), leukoplakia (white or red-and-white patches) and/or a sore (ulcer, growth). Such lesions that persist more than 2 weeks without a diagnosis must be considered potential cancer requiring biopsy and microscopic evaluation.[2]

Due to the absence of pain and/or minimal symptoms of early OPC lesions, there is often a delay in diagnosis. About two-thirds of OPC are diagnosed in advanced stages, requiring aggressive treatment, resulting in higher morbidity and mortality than when diagnosed early. Although the overall 5 year survival rate of OPC remains about 60%,the outcomes vary by stage and location of the disease.[1,3] When diagnosed and treated early, OPCs have more than an 80% 5 year survival rate, compared with less than 30% for a late-stage cancerous lesion.[4]

Tobacco and heavy alcohol use are the chief modifiable risk factors for OPC. Low consumption of fruits and vegetables, a previous oral cancer, advancing age, human papillomavirus (HPV) infection and excessive unprotected sun exposure (for lip cancer)[5-7] are also risk factors for OPC.[8] Assisting tobacco users to stop their tobacco use is essential to reduce the incidence of OPC. Objective 14 of the new long-range goals for Healthy People 2020 relating to preventive interventions in dental offices states:[9]

- Increase the proportion of adults who receive information from a dentist or dental hygienist

focusing on reducing tobacco use or smoking cessation in the past year (Objective 14.1)
- Increase the proportion of adults who receive an oral and pharyngeal cancer screening from a dentist or dental hygienist in the past year (Objective 14.2)

OPC screening and tobacco cessation counseling are very important components of dental hygiene care, since dental hygienists' focus is on oral disease prevention and health promotion.[10] Studies have demonstrated the efficacy of using an OPC screening as a "teachable moment" to promote tobacco cessation.[11,12] Many studies have also supported the need for continuing education (CE) courses for dental hygienists that focus on OPC prevention (e.g., tobacco cessation) and early detection.[13-18] For example, findings from a 2001 national survey of licensed dental hygienists indicated the majority of respondents reported they needed to increase their knowledge of OPC risk factors and their skills for performing a thorough oral cancer screening examination and tobacco cessation counseling. Moreover, 93% expressed interest in attending an OPC CE course related to risk assessment and early OPC detection.[13] The ideal method for the delivery of OPC and tobacco cessation CE is a source of controversy.[19,20] The purpose of this paper is to report changes in dental hygienists' knowledge, attitudes and behaviors 6 months after attending a standardized lecture format CE course on early OPC detection and tobacco cessation counseling. Although both dentists and dental hygienists attended this course, results for only dental hygienists are reported.

Methods and Materials

Study Design

This group longitudinal case study had a pre-/post-test design. The study was approved by the American Dental Association (ADA) Institutional Review Board (IRB). Because this study proposed to survey practicing dental hygienists to evaluate how their knowledge, attitudes and behaviors were affected by attending an OPC screening and tobacco cessation education program, the IRB review stated that the proposed study qualified for an exemption.

Eligibility Criteria

Eligibility criteria for study participation were dental hygienists who worked in clinical practice, enrolled in the standardized CE courses on OPC screening and tobacco cessation offered from 2001 to 2005 and agreed to participate in the study.

Sample Selection, Recruitment and Survey Administration

The study involved a convenience sample of clinical dental hygienists recruited while attending 1 of 64 standardized CE courses on OPC screening and tobacco cessation. The courses were sponsored by the ADA, funded by the National Cancer Institute (NCI) and held in conjunction with state/local dental societies, as well as dental schools and other recognized dental organizations located throughout the U.S.

A coded pre-test was administered at the beginning of each course to establish participants' baseline knowledge, attitudes and practice behaviors regarding OPC screening and tobacco cessation. A mailed similarly coded post-test was administered 6 months post-training. The initial follow-up survey mailing included a cover letter, the coded survey instrument and a pre-addressed, postage paid return envelope. For non-respondents, the initial mailing was followed by a second mailing 2 weeks later, and a phone call 2 weeks later if no response was received from the second mailing. Both pre- and post-test surveys were coded for ease of follow-up and to ensure confidentiality.

Development of Course Content and Evaluation Materials

During year 1 of this 5 year study, the CE course content and the survey instruments were developed, assessed for feasibility and acceptability at 2 workshops held at the ADA headquarters and refined based on feedback.

Final Course Content

The final course content on OPC screening and tobacco use cessation was presented in lecture format and involved 5 clock hours. Two presenters conducted each course with 1 covering the early detection of OPC screening module and the other focusing on the tobacco cessation module. The faculty comprised a pool of 20 professional specialists who underwent standardized training for course presentation.

Tobacco Cessation

The tobacco cessation course content addressed the following topics: forms of tobacco, nicotine dependence and the 5 A's approach to initiating tobacco cessation counseling (Ask about tobacco use, Advise users to quit, Assess readiness to quit,

Assist with the quitting process based on readiness to quit and Arrange follow-up), similar to those presented in the 2008 update of the Clinical Practice Guideline for Treating Tobacco Use and Dependence.[21,22] For counseling tobacco users ready to quit, topics covered were the quit date, triggers for tobacco use, pharmacotherapy, online cessation assistance and quitline referrals, and follow-up during the quit attempt.

For counseling tobacco users not ready to quit, the course addressed the 5 R's (Relevance, Roadblocks, Risks, Rewards and Repetition) to enhance motivation to quit.[21] Although the core content in this regard was similar to that listed in the 2008 Guideline,[21] the style in which the clinician and patient discussion of change was presented in the module was based on the practice of motivational interviewing.[23]

The basic concepts of motivational interviewing are to express empathy by accepting patients as they are and respecting their point of view, help them to develop discrepancy between their current behavior and their desired behavior, avoid arguing with and lecturing them, redirect the conversation to avoid confrontation and support the belief in their ability to change. In this style, the provider employs the structure for the conversation using open-ended questions, affirming feedback, practicing reflective listening and using summary statements. Also, in this style of counseling, the majority of the input originates with the patient.

OPC Screening

The OPC screening module addressed the following topics: epidemiology and risk factors, differential diagnosis, early signs and symptoms, premalignant oral lesions and oral cancer, the OPC screening procedure, adjunctive techniques to accelerate biopsy and management of premalignant lesions to prevent malignant transformations.[24-26]

Survey Measures

The 20-item pre-test survey assessed general demographics and dental hygienists' baseline knowledge, attitudes and practices related to OPC screening and tobacco cessation counseling.

Demographic-related items (n=3)

Among these items, 1 each assessed gender, date of graduation from dental hygiene school (response options: <1980; 1980 to 1989 and ≥1990) and tobacco use status (never/only experimented, former user, current user).

Items related to tobacco cessation (n=6)

An attitude item assessed the importance of tobacco cessation counseling with 5 levels of response options ranging from "very unimportant" to "very important," and a knowledge item assessed contraindications to the nicotine patch. There were 4 performance measures. Item 1 asked about advising patients to quit tobacco (yes/no), item 2 addressed the percentage of patients for whom they update tobacco use status, ask about relapse, age of tobacco use initiation and the quantity used daily. Item 3 assessed the percentage of patients not ready to quit for whom they discuss personal relevance of quitting, roadblocks to quitting and rewards of quitting. Item 4 assessed the percentage of patients ready to quit for whom they discuss setting a quit date, identify tobacco use triggers, discuss pharmacotherapy options and provide follow-up during quit attempts.

Items related to OPC screening (n=11)

An attitude item assessed the importance of OPC screening/detection with 5 levels of response options ranging from "very unimportant" to "very important." One item asked if they understood what comprised an OPC screening (yes/no/not sure) and a knowledge item related to OPC risk factors. Among the 8 performance measures, 1 item asked about performing OPC screening on patients (yes/no), and 7 items assessed the percentage of patients for whom they screened for OPC at the initial dental hygiene visit and at the periodic dental hygiene care appointments post-initial visit for patients aged 13 to 17, 18 to 30, over age 30, over age 40 and for patients with a mucosal sore. The 7 items also assessed the percentage of patients for whom they performed a visual soft tissue exam, retracted the tongue to view lateral borders, palpated the neck and informed the patient of the procedure when doing the OPC screening. One item assessed use of adjunctive tissue diagnostic techniques related to toluiduine blue staining, brush biopsy and Vizlite® (Zila Inc., Fort Collins, Colorado) chemiluminescence. Finally, 1 item assessed the number of patients they referred for a biopsy in the past 12 months.

Data Analysis

Data were coded without personal identifiers and entered into password protected computer files, and hard copies securely stored. Descriptive summaries were performed for all questionnaire variables. For items assessing attitudes on

a 5 point Likert scale ranging from "very unimportant" to "very important," scores 1, 2 and 3 were collapsed into 1 group, and scores 4 and 5 were collapsed into another to create measures of "Somewhat Important/Very Important." Analyses included frequency distributions, chi-square and Fisher's exact tests when categorical variables were compared, t-tests and Mann-Whitney for continuous variables.

In addition, mean follow-up scores in dental hygienists attitudes and behaviors and positive change scores from baseline to follow-up were compared. Dichotomized change was computed as a positive difference between dental hygienists' answers at follow-up and at baseline. The positive change variable was set equal to 0 if the change was negative or zero, equal to 1 if the change was positive and equal to missing if either value was missing. Only baseline data for subjects who returned the follow-up survey were used in the analysis.

Table I: Baseline Smoking Cessation-related Knowledge, Attitudes, and Behaviors of Participating Clinical Dental Hygienists (n=1,463)

Knowledge: Contraindications to Nicotine Patch Use	n*	%
Chose correct answer	340	23.2
Chose incorrect answer	1,123	76.8
Attitude: Importance of tobacco cessation	1,369	95.4
Very important/ Somewhat important	1,120	81.8
Somewhat unimportant	207	15.1
Not at all important	42	3.1
Reported Behaviors (yes)		
Update tobacco use status of continuing patients	1,319	66.0
Ask former tobacco users about relapse	1,293	47.4
Ask tobacco users the age at which started tobacco	1,283	36.0
Ask tobacco users the quantity used daily	1,314	62.7
Advise patients to quit tobacco	1,322	94.3
For patients not ready to quit:		
Discuss personal relevance of quitting	1,308	62.6
Discuss roadblocks to quitting	1,258	46.1
Identify rewards of quitting	1,305	59.7
For patients ready to quit:		
Discuss setting a quit-date	1,259	24.7
Identify tobacco use triggers	1,248	22.7
Discuss pharmacotherapy options	1,275	40.8
Provide follow-up during quit attempt	1,229	8.9

*May vary due to missing data

Results

Demographics

Among the dental hygienists who attended 1 of the 64 standardized courses offered, 1,463 completed the baseline survey. Most were female (99%), and had never tried tobacco or only experimented with it (74%). Nearly half (49%) had graduated in 1990 or later. At follow-up, attrition was 63% (n=543).

Baseline Tobacco Cessation

Table I shows that at baseline over two-thirds reported tobacco cessation counseling was very or somewhat important. On the knowledge question about contraindications for use of the nicotine patch system, only about one-quarter knew the correct answer. Regarding the behavior variables, almost all advised tobacco users to quit using tobacco. Approximately two-thirds reported updating tobacco use status of continuing patients, asking about quantity of tobacco used daily and discussing personal relevance and benefits of quitting with tobacco users not ready to quit. Almost half reported asking former tobacco users about relapse, and about one-third asked current tobacco users the age at which they started using tobacco. With users ready to quit, less than half discussed pharmacotherapy options (41%) and only one-quarter discussed setting a quit date and coping with tobacco-use trigger situations. Less than 10% provided follow-up during a quit attempt.

Baseline OPC Screening

Table II summarizes baseline results for OPC screening. Almost all reported OPC screening was very or somewhat important. Regarding the behavioral variables, almost all reported screening for OPC on patients by visually examining the soft tissue, including retracting the tongue to view lateral borders. Only three-quarters reported that they informed patients of the procedure when doing it and only about half reported palpating the neck for lymph node manifestations. Few reported using adjunctive tissue diagnostic techniques such as toluidine blue, brush biopsy or Vizilite®.

At least 80% reported conducting an OPC screening on smokers over age 40 at their initial visit and at periodic recalls, and on patients with mucosal le-

sions. At least 70% reported screening patients aged 18 to 30 years and patients over age 30. Slightly over half reported screening patients aged 13 to 17 years.

Changes from Baseline to 6 Month Follow-Up in Tobacco Cessation-Related Knowledge, Attitudes and Behaviors

Table III shows significant improvement in knowledge of contraindication to nicotine patch use for smoking cessation, in updating tobacco use status of continuing patients, asking tobacco users about age of tobacco use initiation and asking them the quantity they currently used daily.

Also, in counseling patients not ready to quit, there was significant improvement in discussing roadblocks to quitting and identifying benefits of quitting. In counseling patients ready to quit, there was significant improvement in discussing a quit-date, tobacco use triggers and pharmacotherapy options, and in following-up with those who made a quit attempt.

Changes from Baseline to 6 Month Follow-Up in OPC-Related Knowledge, Attitudes and Behaviors

Table IV shows significant improvement in performing visual exams of soft tissues, retracting the tongue to view lateral borders and in palpating the neck during oral cancer screening. In addition, there was significant improvement in the percentages of patients screened for OPC aged 13 to 17 years, smokers over age 40 and those with mucosal lesions. There was also significant improvement in informing patients of the procedure when doing an OPC screening and in using brush biopsy as an adjunctive tissue diagnostic technique.

Table II: Baseline Oral Cancer Screening-related Knowledge, Attitudes, and Behavior of Participating Clinical Dental Hygienists (n=1,463)

	n*	%
Knowledge: Factor not associated with oral cancer	1,185	81.0
Advancing age	246	20.8
Dental prostheses	194	16.4
Leukoplakia	79	6.7
Diets low in fruits and vegetables	666	56.1
Attitudes: Importance of early cancer detection	1,396	95.4
Very important/Somewhat important	1,356	97.1
Somewhat unimportant	26	1.9
Not at all important	14	1.0
Reported Behaviors (yes)		
Performs oral cancer screening on patients (yes)	1,253	93.6
Patient categories screened for oral cancer:		
Patients age 13-17, initial visit	1,166	64.6
Patients age 13-17, periodic recall after 6 months	1,145	59.8
Patients age 18-30, initial visit	1,230	80.9
Patients age 18-30, periodic recall after 6 months	1,245	77.4
Patients over age 30, initial visit	1,212	82.2
Patients over age 30, periodic recall after 6 months	1,234	79.5
Smokers over age 40, initial visit	1,233	85.2
Smokers over age 40, periodic recall after 6 months	1,255	84.0
Patients with mucosal sore, initial visit	1,229	85.8
Patients with mucosal sore, periodic recall after 6 months	1,252	85.6
Informs patients of procedure when doing oral cancer		
Screening	1,277	76.1
During oral cancer screening:		
Performs visual exam of soft tissue	1,299	92.7
Retracts tongue to view lateral borders	1,291	89.5
Palpates the neck	1,246	50.9
Adjunctive tissue diagnostic techniques used		
Toluiduine blue	810	1.8
Brush biopsy	889	14.7
VizLite	815	2.2
Referred patients for biopsy in past 12 months	1,152	5.0

*May vary due to missing data

Discussion

The ability to routinely identify patients at high risk of developing OPC and to detect the disease at an early stage is a challenge for all health professionals.[13-15,27-29] Dental hygienists see their patients frequently and regularly, and therefore are available to perform routine OPC screening examinations and to encourage and support patient tobacco cessation attempts.

OPC Screening

At baseline, almost all of the dental hygienists in this study recognized the importance of OPC detection. Despite the high level of reported OPC screening, only about half were performing neck palpations. Therefore, even though almost

Table III: Changes in Smoking Cessation-related Knowledge, Attitudes, and Behaviors from Baseline to 6-month Follow-up among Clinical Dental Hygienists who Attended the Continuing Education Course (n=551)

	n	Baseline	Follow-up	Diff	p-value
Attitudes					
Importance of tobacco cessation	516				
Very or somewhat important		81.8%	85.0%	3.2%	0.0811
Somewhat unimportant		16.3%	13.6%	-2.7%	
Not at all important		1.9%	1.4%	-0.5%	
Knowledge					
Contraindications for nicotine patch	406				
Chose correct answer		28.3%	35.0%	6.7%	0.0289*
Reported Behavior					
Update tobacco use status of continuing patients	505	67.8%	72.6%	4.8%	0.0011*
Ask former tobacco users about relapse	495	50.3%	51.1%	0.8%	0.6561
Ask tobacco users the age at which started Tobacco	482	35.3%	40.5%	5.2%	0.0027*
Ask tobacco users the quantity used daily	501	64.2%	68.1%	3.9%	0.0042*
Advise patients to quit tobacco	537	95.5%	96.1%	0.6%	0.6020
For patients not ready to quit:					
Discuss personal relevance of quitting	496	64.3%	66.6%	2.3%	0.2031
Discuss roadblocks to quitting	467	48.3%	53.2%	4.9%	0.0058*
Identify rewards of quitting	489	61.8%	64.7%	2.9%	0.0737*
For patients ready to quit:					
Discuss setting a quit-date	475	25.5%	37.5%	12.0%	<0.0001*
Identify tobacco use triggers	466	24.5%	38.6%	14.1%	<0.0001*
Discuss pharmacotherapy options	482	43.0%	55.9%	12.9%	<0.0001*
Provide follow-up during quit attempt	453	8.3%	13.6%	5.3%	0.0001*

*Significant Improvement from baseline values; n varies due to missing data; only baseline data for subjects who returned the follow-up survey were used in the analysis

all thought they were performing comprehensive OPC screening, only half were doing so. At the 6 month follow-up, the CE participants reported a significant improvement compared to baseline values, in understanding what comprises a thorough OPC screening and in palpating the neck as part of the examination. There was also a significant improvement in the percentage of dental hygienists who informed patients of the OPC screening procedure while performing the examination. This finding is very important since public awareness about the risk factors and methods of early OPC detection is very low,[30,31] and increased awareness can help both patients and health care providers detect lesions early.[17,30-33]

The primary method for detecting OPC is a comprehensive screening examination which the American Cancer Society recommends annually for people 40 years or older.[34] Six months after being exposed to the CE course, there was significant improvement in the CE participants' report of performing OPC screenings of patients over age 30 and patients with mucosal lesions, and of informing patients of the OPC screening procedure when performing it. Such improvement is very important since only 20% of Americans 40 years or older have reported having had an OPC examination in their lifetime.[33] Also, at the 6 month assessment, there was a slight improvement in the respondents' report of using brush biopsy as an adjunctive tissue diagnostic technique. The value of adjunctive techniques is to accelerate biopsy and to help select the best area for biopsy. They are non-invasive, cost-effective and quick to perform.

Disappointingly, there was no improvement in knowledge of OPC risk factors from baseline to follow-up, indicating a need for increased emphasis on these aspects of the CE curriculum offered. It is critical for dental hygienists to know the risk factors for OPC and to be proficient in assessing them when taking health histories, including as-

Table IV: Changes in Oral Cancer Screening-related Knowledge, Attitudes, and Behaviors from Baseline to Follow-up among Participating Clinical Dental Hygienists (n=551)

	n	Baseline	Follow-up	Diff	p-value
Knowledge: Factor not associated with oral cancer	408				
Advancing age		22.1%	21.1%	-1.0%	0.8212
Dental prostheses		15.9%	15.4%	-0.5%	
Leukoplakia		5.4%	8.1%	2.7%	
Diets low in fruits and vegetables		56.6%	55.4%	-1.2%	
Attitude: Importance of oral cancer detection	537				
Very or somewhat important		97.1%	98.1%	0.7%	0.2855
Somewhat unimportant		2.0%	1.5%	-0.5%	
Not at all important		0.6%	0.4%	-0.2%	
Reported Behaviors: (Yes)					
Performs oral cancer screening on patients	525	94.9%	96.2%	1.3%	0.1443
Perform oral cancer screening on:					
Patients age 13-17, initial visit	394	69.4%	76.7%	7.3%	0.0005*
Patients age 13-17, periodic recall after 6 months	384	65.9%	72.1%	6.2%	0.0011*
Patients age 18-30, initial visit	428	88.4%	90.9%	2.5%	0.1217
Patients age 18-30, periodic recall after 6 months	449	84.9%	86.4%	1.5%	0.2853
Patients over age 30, initial visit	420	89.6%	92.7%	3.1%	0.0207*
Patients over age 30, periodic recall after 6 months	447	86.6%	89.1%	2.5%	0.0538*
Patients over age 40, initial visit	439	91.7%	93.9%	2.2%	0.0783*
Smokers over age 40, periodic recall after 6 months	472	90.3%	92.6%	2.3%	0.0554*
Patients with mucosal sore, initial visit	436	92.5%	94.7%	2.2%	0.0780*
Patients with mucosal sore, recall after 6 months	468	91.7%	94.7%	3.0%	0.0112*
Informs patients of procedure when doing oral cancer screening	502	75.7%	78.9%	3.2%	0.0353*
During oral cancer screening:					
Performs visual exam of soft tissue	514	93.2%	95.4%	2.2%	0.0520*
Retracts tongue to view lateral borders	512	89.4%	92.6%	3.2%	0.0135*
Palpates the neck	486	49.6%	58.3%	8.7%	<.0001*
Uses adjunctive tissue diagnostic techniques:					
Toluiduine blue	180	1.2%	2.1%	0.9%	0.2700
Brush biopsy	231	20.1%	25.1%	5.0%	0.0101*
VizLite	183	2.3%	3.3%	1.0%	0.4069
Referred patients for biopsy in past 12 months	416	7.2	5.8	-1.4	0.3525

*Significant improvement from baseline values; n varies due to missing data; only baseline data for subjects who returned the follow-up survey were used in the analysis

sessment of past and present alcohol use, past and present tobacco use, type and amount of alcohol and tobacco used, and personal and family history of cancer. Such information is essential for patient education and counseling to prevent OPC.

These findings are consistent with those of others supporting the need for CE courses in OPC to increase dental hygienists' knowledge of risk factors, to correct misinformation and to increase the translation of this knowledge into OPC screening and early detection.[13-18]

Another reason for only moderate improvement since 1973 in U.S. OPC early detection and survival rates is the public's lack of knowledge about risk factors and early signs of OPC. Effective behavioral risk reduction strategies must begin with personal risk awareness.[35] The American Cancer Society not only recommends that health care providers perform periodic OPC examinations, but that they also include health counseling about OPC risk factors, such as alcohol and tobacco use, unprotected excessive sun exposure, diet and nutrition, and high-risk sexual practices that may be related to HPV transmission.[34] The extent to which

health care workers actually provide this counseling is unknown.[30] With dental hygienists' broad focus on oral disease prevention and health promotion, they are well positioned to obtain a focused health and behavioral history that includes the key risk factors for OPC, to screen for OPC signs and symptoms and to counsel patients about their findings. Findings from focus groups of dental hygienists in 2 states report that they perceive their most important contribution to OPC control in the areas of patient education to increase OPC risk factor awareness, and of OPC screenings.[16,18]

Tobacco Cessation

Since a major risk factor for OPC is tobacco use, the standardized CE course evaluated in this study focused on tobacco cessation counseling as well as OPC screening. With regard to tobacco cessation, over two-thirds of dental hygienists at baseline recognized the importance of tobacco cessation counseling, and almost all advised tobacco users to stop using tobacco. The high response observed at baseline produced a "ceiling effect," which was a limiting factor for this measure in course evaluation.[19] Nevertheless, compared to baseline values, at the 6 month assessment course participants reported a significant 7% increase in specific knowledge of nicotine patch use. For patients ready to quit tobacco use, there was significant increase in course participants who discussed setting a quit date, identified tobacco triggers, discussed pharmacotherapy and provided follow-up during quit attempts. For patients not ready to quit, there was a significant increase in course participants who discussed personal relevance of quitting and rewards of quitting. It is important to note, however, that despite the significant positive change scores at follow-up compared with baseline values, no more than about one-quarter of the dental hygienists actually knew about nicotine patch contraindications, updated tobacco use status of continuing patients, discussed setting a quit-date and coping with tobacco use triggers or provided follow-up with patients making a quit attempt. These low response scores may be explained by the fact that the follow-up did not assess referral to quitlines or web-based cessation programs as methods of providing assistance to tobacco users. Dental hygienists are well versed in the "Ask, Advise and Refer" program, the primary aim of the American Dental Hygiene Association's educational campaign for tobacco cessation,[36] and it is likely that many of the respondents referred their patients for such cessation assistance rather than providing it directly to their patients as measured by outcome variables.

It is noteworthy that the 6 month assessment showed significant improvement in dental hygienists' report of applying the 5 Rs in counseling patients not ready to quit.[21] Moreover, at follow-up, over half discussed personal relevance of quitting and rewards of quitting, and almost half discussed roadblocks with patients not ready to quit. In the dental hygiene care setting there are multiple opportunities for tobacco-use intervention services. Failure to provide a brief intervention is an important missed opportunity,[27] since there is evidence that dental patients are traditionally receptive to disease prevention messages.[37]

Lecture Educational Format

Findings from our study suggest that the lecture format used in the CE course significantly increased performance of both OPC screening and tobacco use cessation counseling among the dental hygienists who attended the CE course compared to baseline values. These findings are consistent with those of a recent randomized controlled trial of approaches to translating the Clinical Practice Guideline for Treating Tobacco Use and Dependence into dental settings.[38] That study concluded exposure to either a workshop or mailed self-study materials improved practice behaviors on key tobacco use cessation outcomes compared to usual care. Positive change scores in dentists' attitudes and behaviors, however, were significantly better in the workshop-group that included some hands-on training compared to self-study.[38] Nevertheless, group education sessions using the lecture format have been reported to contribute significantly to increased performance of both tobacco use cessation and OPC screening behaviors among dentists exposed to the same standardized lecture format CE course compared to matched controls.[19,20] The use of a lecture format session for large groups may be an efficient and cost-effective public health method of teaching dental professionals about the latest science of OPC screening and tobacco use cessation. Further study is needed in this area.

Moreover, it is critical that training in OPC and tobacco cessation counseling in lecture and/or hands on training formats needs to be included in all dental hygiene school curricula. In addition, CE courses need to be made available on a routine basis to maintain current knowledge about OPC and tobacco cessation and to improve practice shortcomings with regard to OPC screening, prevention and early detection. This recommendation is consistent with opinions expressed by dental hygienists in focus groups held in Maryland and North Carolina, wherein participants stated

that there is always a need for CE in OPC screenings and tobacco cessation, specifically for hands-on-courses.[16,18] Moreover, some focus group participants recommended that updates on how to conduct an OPC examination be a requirement for licensure maintenance, as updates on infection control are now required in many states.[16]

Limitations. Our findings are limited to the dental hygienists attending the CE course under evaluation and may not be representative of all dental hygienists nationally. The generalizability of our findings is limited because in this study it was not possible to randomly select participants. A control group unexposed to the CE course would have been helpful for comparison. Therefore, secular trends may affect internal validity of study outcomes. Additionally, our findings are limited by the 37% response rate at follow-up. The study participants may have been more motivated to engage in cessation counseling and OPC screening than those who were not able to participate.

Conclusion

The findings support the theory that CE courses can improve dental hygienists' knowledge and behavior regarding OPC screening and tobacco cessation counseling. Such CE courses can be very useful to help ensure that dental hygienists are meeting their responsibilities for early detection and referral of possible OPC lesions as part of their commitment as professional oral health care providers.

Margaret M. Walsh, RDH, MS, MA, EDD, is a professor of Preventive and Restorative Dental Sciences, School of Dentistry at the University of California San Francisco. K. Vendrell Rankin, DDS, is a professor and associate chair in the Department of Public Health Sciences, Texas A&M University Baylor College of Dentistry. Sol Silverman, JR., MA, DDS, is a professor emeritus of Oral Medicine, School of Dentistry, University of California San Francisco.

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