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.

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FEATURES

EDITORIAL

Living to Serve

Rebecca S. Wilder, RDH, BS, MS

Our profession experienced a tragedy earlier this year that impacted the world. A dental student from the University of North Carolina, Deah Barakat, his wife, Yusor Abu-Salha, and sister-in-law, Razan Mohammad Abu-Salha, were killed at gunpoint in February, 2015. Deah was a second year dental student. His wife of 6 weeks had been accepted into the dental school class of 2019. Her sister was a sophomore at North Carolina State University. Deah was known for his giving spirit, always working for others. He and 10 local dentists and faculty had planned a trip to Turkey this past summer to provide dental care to Syrian refugees and he had initiated a fundraising video to raise money for the trip.[1] Deah was known for volunteering and giving of his time. It was typical for Deah and Yusor to give their weekends to serve others. Organizations such as Habitat for Humanity, the Light House in Raleigh, NC and those that serve the homeless were important to Deah and Yusor. Kaushal Gandi, a dental hygienist and fellow dental student with Deah noted, "After the tragic losses of Deah, Yusor and Razan, there were many requests to honor their legacy. Deah and Yusor were aspiring dentists and volunteered regularly within their communities. All three would have gone on to have illustrious careers and continue their community outreach and spirit of service locally and internationally. Their legacy is that of learning, service, humanity, faith and compassion."[2]

The tragedy of that day will never go away but what has happened to carry on his legacy will live forever. The first DEAH DAY was held on September 17th in North Carolina. DEAH DAY stands for Directing Efforts And Honoring Deah And Yusor. It was an idea inspired by students and supported by the UNC School of Dentistry Dean's Office, students (dental, dental hygiene, dental assisting), faculty and the Dental Foundation of North Carolina. The students wanted to create an event that would exemplify the victims' commitment to service. What happened next is remarkable. Over 350 students and faculty volunteered to serve that day. Twenty-two organizations were selected for various service projects including Goodwill, Interfaith Food Shuttle, Meals on Wheels, Alliance of AIDS Services, etc. Volunteers clocked a total of 1,200 hours, all within a morning of service on September 17th. The events of the day were posted on 208 websites with a potential total audience of over 15 million! A talent show ended the day with over $3,600 raised for Habitat for Humanity. So many people came together in a short period of time to make a difference in the lives of others.

This tragedy will scar our hearts forever but the loving, selfless spirit of these three young, loving Muslim students will live forever in our hearts. How can we all carry on the legacy of a fellow dental professional who lived to serve? Deah would tell us to get out of ourselves and do for others. You don't have to possess a special talent to make a huge difference in the lives of other human beings. Can you spend a few hours each year or each month to help in your community? What will you do to make a difference?

Sincerely,

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

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REVIEW OF THE LITERATURE

Obstructive Sleep Apnea and the Role of Dental Hygienists

Elizabeth Collins Kornegay, RDH, BSDH; Jennifer L. Brame, RDH, MS

Abstract

Purpose: Obstructive Sleep Apnea (OSA) is the most commonly undiagnosed sleep disorder and is gaining more recognition in dentistry. Dental hygienists are at a pivotal position to discuss risks, characteristics, medical referrals and treatment options for OSA, as well as detect if an individual has OSA through questionnaires and other tools that can be done during an examination. Dental hygienists need to receive appropriate education about OSA and should be well versed in their knowledge to educate patients. The purpose of this literature review is to identify the role of the dental hygienist in detecting the risk of OSA and gain knowledge on the topic in order to educate patients.

Keywords: obstructive sleep apnea, dental hygiene, sleep disorders, OSA detection

This study supports the NDHRA priority area, **Clinical Dental Hygiene Care:** Investigate how dental hygienists identify patients who are at-risk for oral/systemic disease.

INTRODUCTION

Dental clinicians play a vital role in patient's oral and systemic health. Research indicates patients are 24.1% more likely to visit the dentist as compared with an annual exam by a physician; thus, dental health professionals are in a position to be the first providers to detect systemic health conditions.[1] Dental hygienists play a crucial role in detecting disease and health risks and are able to communicate findings to their patients. Therefore, it is essential that dental hygienists are knowledgeable about systemic and oral health conditions enabling them to discuss risks, characteristics of diseases, medical referrals and treatment options.

Obstructive Sleep Apnea (OSA) is a health condition for which the dental community can identify and screen. However, less than 50% of dentists are actually capable of identifying the signs and symptoms of this sleep disorder.[2] OSA is the most common breathing disturbance,[3] with up to 80% of moderate to severe OSA remaining undiagnosed.[4] This sleep disorder is defined as repeated episodes of complete or partial obstruction of the upper airway during sleep and characterized by snoring, witnessed stopped breathing and excessive daytime sleepiness.[3-4] OSA is associated with many health conditions such as hypertension,[4-7] reduced quality of life[4,7] and diabetes mellitus.[2,5] There is also a significant association between OSA and moderate to severe periodontitis.[8-10] This correlation suggests that optimum oral health is imperative, especially when there is risk for OSA.

OSA is important to dentistry because dental professionals have the opportunity to screen for risk factors and disease patterns of OSA and have the ability to assess one's risk. There are several OSA detection tools available that determine risk of OSA. The purpose of this literature review is to identify the role of the dental hygienist in detecting the risk of OSA and to gain knowledge on the topic in order to educate patients.

Definition and Categories of Sleep Apnea

Sleep Apnea is a medical disorder characterized by 50% decrease in airflow (hypopnea) or the complete cessation of airflow (apnea) occurring longer than ten seconds while sleeping.[6,8] The apnea-hypopnea index (AHI) is the most common index for assessing the severity of sleep apnea by combining the number of apneas and hypopneas each night (Table I).

There are 3 categories of sleep apnea: OSA, central sleep apnea and complex sleep apnea. OSA is the occurrence of 5 or more events per night of apnea and hypopnea due to an obstruction of the airway.[11] Central sleep apnea is defined as a decrease in oxygen saturation levels due to the brain failing to deliver a signal for the body to breathe, resulting in ineffective and shallow breaths.[11] Complex sleep apnea is a combination of OSA and central sleep apnea.

OSA: Characteristics, Risk Factors and Health Related Conditions

OSA received clinical recognition in the 1980s and has gradually gained recognition in the research setting.[12] OSA remains the most common undiagnosed

sleep disorder and chronic disease in Western society.[2] Recent research suggests up to 80% of moderate to severe cases of OSA are underdiagnosed,[4] and 1 in 5 adults have mild OSA and 1 in 15 have moderate OSA.[13] Characteristics of OSA include snoring, daytime sleepiness and witnessed stopped breathing during sleep. Other symptoms are the sensation of choking while sleeping, insomnia and daytime tiredness. Oral manifestations include attrition and a large tongue, along with the physical characteristic of a neck larger than 17 cm.

Obesity is considered the greatest risk factor associated with OSA. Even a person with mild to moderate obesity is at an increased risk for having OSA.[5] Also, people with a high body-mass index, large neck circumference and a high waist-to-hip ratio are at risk for developing OSA.[4,5] Due to excessive daytime sleepiness, individuals are at an increased risk of motor vehicle accidents when left untreated.[14] Research suggests that African Americans have a 2–times greater risk to have OSA than Caucasians.[15] Males have a greater predilection[4,5] for OSA, about 2 to 3-fold than women.[16] However, menopause and pregnancy may be an exception due to physiological and hormonal changes.[13] Other risk factors include alcohol consumption,[4] smoking,[4] nasal congestion[10] and upper airway anatomy.[4]

OSA is independently linked to and increases the likelihood of several health-related conditions such as hypertension,[4-7] decreased quality of life,[4,7,17] diabetes mellitus,[2,5] stroke[2] and diminished neurocognitive function.[4] Additionally, there is an increased risk of congestive heart failure, coronary artery disease, myocardial infarction and cardiac arrhythmias.[2]

Recent research has found an increase in periodontitis in individuals with OSA[8] as they share several risk factors such as male sex, older age, obesity, oral breathing, cigarette smoking and alcohol consumption.[8] OSA and periodontitis are both associated with systemic inflammation and cardiovascular risk. Gunaratnam et al suggests, "There is a significant association between periodontal clinical attachment level and total sleep time."[9] Furthermore, there is a positive significant association between OSA and periodontitis.[8,10]

Diagnosing OSA – Polysomnography: The Gold Standard

Polysomnography is considered the gold standard of diagnosing OSA and is completed in a laboratory. This diagnostic tool measures an individual's sleep cycles and stages, recording air flow in and out of the lungs, blood oxygen levels, brain waves, eye movement, and heart rate.[18] The disadvantages of the polysomnography are: low availbility, cost and time-consumption.[3,7] Because of the disadvantages,

Table I: Apnea-Hypopnea Index[4]

Mild	5 to 15 respiratory events/hour
Moderate	15 to 30 respiratory events/hour
Severe	More than 30 respiratory events/hour

Table II: Mallampati Classification

Classification	Visualization	
Class I	Soft palate, entire uvula	Normal
Class II	Soft palate, portion of uvula	Normal
Class III	Soft palate, possible base of uvula	Abnormal, high risk for OSA
Class IV	Hard palate only, soft palate not visible	Abnormal, high risk for OSA

screening tools have been developed that may assist in identifying high risk individuals. These tools may help serve the population by alerting those who are at risk, allowing them the opportunity to seek out definitive diagnosis.

Screening Tools for Detecting Risk of Obstructive Sleep Apnea

Although physicians are the only professionals licensed to diagnose OSA, dentists and dental hygienists can detect OSA risk through screening tools. Some of these tools are the Mallampati Classification,[19-21] Epworth Sleepiness Scale,[22,23] STOP Questionnaire,[3] STOP-BANG Questionnaire[24] and ARES Questionnaire.[2]

Mallampati Classification

The Mallampati Classification is an evaluation predicting the ease of intubation and is higher in people who show severe degrees of OSA.[19,20] With the patient sitting upright, mouth open and tongue protruded, the evaluator classifies the visibility of the posterior pharynx with aid of a light with a scale of I, II, III and IV (Table II, Figure 1).[21] A score of I and II are considered adequate exposure of the posterior pharynx, while a score of III and IV are considered inadequate exposure of the posterior pharynx.[20] Kandray et al assessed the inter-rater reliability of using the Mallampati classification between dental hygiene students and a supervising dentist to evaluate and classify the pharyngeal soft tissues.[19] After training by a licensed respiratory therapist, 21 dental hygiene students received a diagram with the Mallampati Classification and placed a check mark beside the image that best represented the patient's oropharynx opening during a dental hygiene appointment. Subsequently, the dentist did an independent

Figure 1: Mallampati Classification Oral Anatomy

CLASS I   CLASS II   CLASS III   CLASS IV
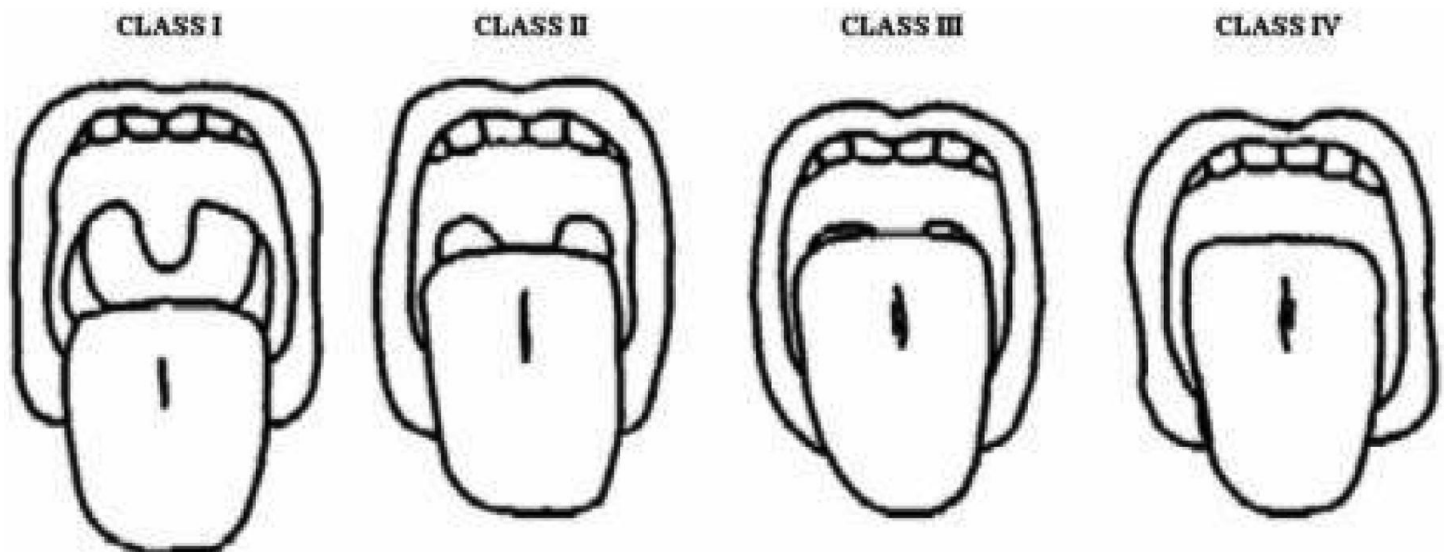
Borrowed with permission from Thomas Nuckton's Study[21]

evaluation of each patient using the same type of diagram that the student used after the same training. The results show a 77% agreement between the dentist and students, indicating that dental hygiene students can classify oropharyngeal tissues.[19]

Epworth Sleepiness Scale

The Epworth Sleepiness Scale (ESS), developed by Murray Johns in 1991, is a self-administered questionnaire that evaluates sleep tendencies.[23] An individual rates their chance of dozing off in 8 different scenarios in this subjective questionnaire (Tables III, IV).[22] An ESS score of 16 or greater is considered a high level of daytime sleepiness, which is one of the most common symptoms for OSA.[17] Nguyen et al conducted a study to evaluate the reproducibility of the ESS.[22] In this study, 142 patients were evaluated and it was found that there were discrepancies when the ESS was repeated over time in the same untreated individual. The researchers cautioned that the ESS should not be the sole tool to indicate risk for possible OSA due to reproducibility discrepencies.[22]

STOP Questionnaire

Chung et al constructed a concise screening tool for OSA called the STOP questionnaire (Table V).[3] The initial goal was to find a tool for identifying OSA risk in patients soon undergoing surgical procedures; recently it has begun to identify any patient at risk. If a patient answers "yes" to two or more of the questions, then they are considered at high risk.

Chung et al investigated 278 patients who answered 14 questions in order to identify the best questions to ask to identify OSA. This investigation culminat-ed in the 4-question STOP questionnaire.[3] Then a pilot study was implemented on 592 preoperative clinic patients to ensure the strength of the STOP questionnaire. After the pilot study, the questionnaire was administered to 1,875 patients with a 100% completion rate. Then, regardless of the score, they were all asked to undergo an overnight polysomnographic. The AHI from the polysomnography was used against the STOP questionnaire in order to validate it. Two hundred and eleven patients agreed to the polysomnography (34 from the pilot study, 177 from the study). Overall, it was found that the STOP questionnaire had a moderately high sensitivity and positive predictive value, indicating that the STOP questionnaire is more sensitive in determining if one has moderate to severe OSA. The positive predictive value was significantly increased when people have the following clinical characteristics: male gender, age older than 50 years, BMI greater than 35 kg/m2, and neck circumference greater than 40 cm.[3] The study concluded that the STOP questionnaire is an easy-to-use screening tool for patients at risk with OSA.[3]

Other studies have used the STOP questionnaire to determine OSA risk. Ahmad et al found that the STOP questionnaire aided in identifying one's risk of OSA and confirmed that the prevalence of periodontitis may be higher in patients with OSA.[8]

Table III: Epworth Sleepiness Scale[21]

0	No chance of dozing off
1	Slight chance of dozing off
2	Moderate chance of dozing off
3	High chance of dozing off

Table IV: Epworth Sleepiness Scale Questions[22]

Situation
1. Sitting and reading
2. Watching TV
3. Sitting, inactive in a public place
4. As a passenger in a car for an hour without a break
5. Lying down to rest in the afternoon when circumstances permit
6. Sitting and talking to someone
7. Sitting quietly after a lunch without alcohol
8. In a car, while stopped for a few minutes in traffic

Table V: STOP Questionnaire[3]

Snoring	Do you snore loudly?
Tired	Do you often feel tired, fatigued, or sleepy during daytime?
Observed	Has anyone observed you stop breathing during your sleep?
Blood Pressure	Do you have or are you being treated for high blood pressure?

Table VI: STOP-Bang Questionnaire[23]

Snoring	Do you snore loudly?
Tired	Do you often feel tired, fatigued, or sleepy during daytime?
Observed	Has anyone observed you stop breathing during your sleep?
Blood Pressure	Do you have or are you being treated for high blood pressure?
BMI	BMI more than 35 kg/m2?
Age	Age over 50 years old?
Neck Circumference	Neck circumference greater than 40 cm?
Gender	Gender male?

STOP-Bang Questionnaire

The STOP-Bang questionnaire is a series of 8 questions with scores ranging from 0 to 8 (Table VI).[24] If an individual answers yes to 3 or more items, then they are considered at high risk for OSA. Research indicates that a STOP-Bang score of 3 or greater reveals a high sensitivity for moderate to severe OSA along with an increase in specificity and predicted probability.[24]

The Apnea Risk Evaluation System Questionnaire

The Apnea Risk Evaluation System (ARES) can sufficiently assess the risk of an individual with undiagnosed OSA.[2] Levendowski et al assessed the prevalence of potential OSA in a dental population by administering this questionnaire to 2 dental practices.[2] The first practice had no prior OSA treatment experience and the questionnaire was given to the patients at a scheduled dental appointment with 229 patients fully completing the ARES questionnaire. The second practice had 15 years of prior experience with OSA treatment and the questionnaire was mailed to 870 patients with 102 returning it fully completed. Including both practices, 102 patients were considered high risk upon completing the questionnaire and were selected to complete a 2-night sleep study. During the night, the patients wore a wireless unicorder on their foreheads that recorded oxygen saturation, pulse rate, airflow, respiratory effort, snoring levels, head movement and head position. Results from the ARES questionnaire found that 67% of males were at high risk of having at least mild OSA and 33% at risk for having moderate to severe OSA. Twenty-eight percent of females had at least mild OSA and 6% had moderate to severe OSA. Out of the 105 high-risk patients participating in the sleep study, 96% had an apnea hypopnea index (AHI) greater than 5 events per hour[2] and 70% had an AHI of greater than 20 events per hour. In conclusion, the study found a high prevalence of undiagnosed sleep apnea in this dental population,

providing additional evidence that the ARES can sufficiently assess the risk of an individual with undiagnosed OSA.

Treatment Options for Obstructive Sleep Apnea

Treatment of OSA includes lifestyle changes such as weight loss,[25] upper airway surgery,[25] continuous positive airway pressure (CPAP)[25-27] and oral appliances.[28,29]

Continuous Positive Airway Pressure

CPAP is the gold standard treatment of OSA and is effective in decreasing the nocturnal events of OSA.[25] Research suggests the therapeutic effects of being on CPAP for 3 weeks significantly reduces fatigue and increases energy in individuals with OSA.[26] It has also been found that CPAP reduces cardiovascular risk, fatal or nonfatal cardiovascular events, and blood pressure within 3 weeks time of complying with CPAP treatment.[27] CPAP improves glucose control in diabetic patients suffering from severe OSA.[6] However, many individuals have difficulty complying due being uncomfortable while sleeping and the changes in occlusion. Mehta et al[6] conducted a follow-up study to Chung et al,[24] by contacting the patients who participated in OSA treatment. Among the patients given CPAP therapy, 40 stated they were compliant and had significant reductions in medica-

tions for comorbidities than the patients who were non-compliant. Additionally, the patients who were compliant showed a significant improvement in snoring, sleep quality and daytime sleepiness. Based on these results, the researchers concluded OSA symptoms and severity of comorbidities might be reduced by timely diagnosis and compliance to treatment.[6]

Oral Appliances

Oral appliances are typically used when a patient does not like CPAP, has not responded to CPAP or is not appropriate for CPAP. The appliances are small, easy to wear and typically take only a few weeks for patients to adjust. Before receiving, the patient has an examination to determine which oral appliance is most appropriate, fit and adapt the appliance, and determine the function. Dentists construct and fit oral appliances.[25] Oral appliances for OSA treatment include tongue retaining devices and mandibular advancement appliances.[28] Tongue retaining devices are seldom used except when dental reasons prohibit making mandibular advancement appliances. The appliance holds the tongue in a forward position with a suction bulb that prevents the tongue from obstructing the airway. The most commonly used oral appliance is the mandibular advancement appliance. Mandibular advancement appliances work by protruding the mandible forward, which minimizes upper airway collapse while sleeping. Treatment with oral appliances is non-invasive and reversible,[28] accompanied occasionally with initial side effects of tooth pain, temporomandibular joint pain, dry mouth, gum irritation and excessive salivation.[29]

DISCUSSION

While dentists and dental hygienists cannot diagnose OSA, they have the opportunity to play a crucial role in the detection, education, medical referral and treatment in OSA. Research for OSA is emerging and revealing a role for screening and treatment in dentistry. Because patients are more likely to visit their dentist than physician in a year, dental hygienists and dentists can play an integral role in the detection of OSA by screening and referring high-risk patients to physicians. This can provide patients with interprofessional care by facilitating aid in OSA treatment from the dentist, dental hygienist and physician. Collaboration with dentistry and medicine is pivotal because it establishes a team between the disciplines and provides patients with the best standard of care.

Dental hygienists can use screening tools, like the Mallampati classification, STOP questionnaire and STOP-BANG questionnaire, which provide an opportunity to assist in detection. Research studies suggest dental hygienists can effectively use these tools in an appointment. While screening tools are available, these tools need further research on their reliability and validity to provide further proof of the effectiveness. As stated in Nguyen et al, more research is needed to evaluate the reproducibility of the Epworth sleepiness scale.[24]

As emerging research suggests a relationship between OSA and periodontal disease, OSA screening may become more important for periodontal risk assessment. Current studies have indicated that OSA may increase periodontitis presence by contributing to increased systemic inflammation. Dental hygienists are in an optimum position to educate patients on periodontitis and ways to arrest the condition (i.e. OSA) through oral hygiene instructions. Further research is needed to determine the causal relationship between OSA and periodontitis.

Most dental school curricula do not provide adequate content for sleep apnea.[30] It is imperative that sleep disorder education is presented in the curriculum of dental and dental hygiene programs as research has suggested that there are screening tools that can effectively detect OSA. After diagnosis, the dental team can aid in the patient's treatment of OSA and play a crucial role in helping people who suffer from it. Furthermore, patients typically value what their dental hygienists say; therefore, it is important that hygienists receive education pertaining to sleep disorders, so the patient receives evidence-based facts regarding this disorder.

CONCLUSION

Dental hygienists are at a pivotal position to assist the interprofessional team in screening for OSA. As patients are more likely to visit their dentist regularly compared with a physician, more opportunities arise for screening and detection of systemic diseases including OSA. The tools used to detect OSA are easily implemented during the evaluation or during the intraoral examination performed. Dental hygienists have the opportunity to educate the patient on risk factors, potential health conditions, and treatment options for OSA. Medical referrals are also part of the dental hygienist role, initiating the collaboration between the medical and dental fields. By including the dental team in screening and detection for OSA, patients may be more likely to receive accurate diagnosis and seek treatment, thus improving their overall quality of life.

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INNOVATIONS IN EDUCATION AND TECHNOLOGY

E-Model for Online Learning Communities

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Abstract

Purpose: The purpose of this study was to explore the students' perspectives on the phenomenon of online learning communities while enrolled in a graduate dental hygiene program.

Methods: A qualitative case study method was designed to investigate the learners' experiences with communities in an online environment. A cross-sectional purposive sampling method was used. Interviews were the data collection method. As the original data were being analyzed, the researchers noted a pattern evolved indicating the phenomenon developed in stages. The data were re-analyzed and validated by 2 member checks.

Results: The participants' experiences revealed an e-model consisting of 3 stages of formal learning community development as core courses in the curriculum were completed and 1 stage related to transmuting the community to an informal entity as students experienced the independent coursework in the program. The development of the formal learning communities followed 3 stages: Building a Foundation for the Learning Community, Building a Supportive Network within the Learning Community and Investing in the Community to Enhance Learning. The last stage, Transforming the Learning Community, signaled a transition to an informal network of learners. The e-model was represented by 3 key elements: metamorphosis of relationships, metamorphosis through the affective domain and metamorphosis through the cognitive domain, with the most influential element being the affective development.

Conclusion: The e-model describes a 4 stage process through which learners experience a metamorphosis in their affective, relationship and cognitive development. Synergistic learning was possible based on the interaction between synergistic relationships and affective actions.

Keywords: dental hygienists/education, education, distance online systems, teaching/methods, learning, program development

This study supports the NDHRA priority area, **Professional Education and Development:** Evaluate the extent to which current dental hygiene curricula prepare dental hygienists to meet the increasingly complex oral health needs of the public.

INTRODUCTION

Online learning is an increasingly prevailing method of delivering higher education, especially among nontraditional students and graduate level students.[1,2] Asynchronous learning offers many benefits to students who are trying to increase their educational levels while fulfilling employment or family responsibilities.[1] Benefits stem from the flexibility to accommodate the student's schedule with completing assignments, viewing instructional materials and communicating with peers or instructors on discussion boards.[3] To decrease the feeling of isolation that can occur with asynchronous learning, some educators teaching in online formats have found it worthwhile for learners to develop a sense of community to enhance the educational experience.[4]

A learning community can be described as a group of learners who participate in communication and collaborate with their peers and faculty, for the purpose of learning from one another.[5] According to Rogo and Portillo, an online learning community is more than just learning in an online format; it is a "complex synergistic network of interconnected people who create positive energy."[6] This network focuses on relationships among learners who value each other and are committed to a shared vision to work together to provide a healthy exchange of ideas and create new ideas in a safe environment.[6] Community develops through social interaction between students and with faculty who actively engage in the course content.[6]

Online learning opportunities in higher education have evolved from individual course offerings to entire degree programs. However, research has continued to focus on the development of learning communities in a single course during 1 semester. Liu and colleagues suggested that building learning communities is a "complex sociocultural phenomenon" requiring a longitudinal focus to determine the development of this phenomenon over time.[7] Therefore, the literature reviewed was focused on the phenomenon of online learning communities over the course of an academic program or a cross-sectional approach to data collection using multiple levels of

students enrolled in a program. This approach to the literature review was deemed appropriate to establish a holistic perspective of the phenomenon.

Brown was a pioneer in studying the process of community building by conducting a qualitative study using novice and experienced online learners enrolled in a graduate program to inform the development of a grounded theory.[8] A 3–stage process for community development was created from the data analysis.[8] The first stage of this phenomenon was experienced as students met each other within the online course. Some students developed friendships based on finding commonalities in aspects of their lives such as their backgrounds, circumstances and personal characteristics. These friendships influenced active communication with each other throughout a course. The second stage was characterized as being accepted as a member of the learning community. Membership was earned by making contributions to the threaded discussions and peers building on those ideas. Students felt a sense of satisfaction and having a relationship among students who participated in the discussion. This membership increased self-confidence, especially in those students who were at the novice level of online learning. Expert learners who were "community-minded" facilitated the novice students' development though modeling positive interaction and providing support.[8]

The third and highest stage of community development was establishing camaraderie by making interaction a priority within courses.[8] Students who experienced this level generally had ongoing personal contact through intense interaction in one course, communication outside of the online course, enrollment in several courses together and/or interaction during a face-to-face summer session.[8] Informal communication was an important aspect of promoting camaraderie and building friendships.[8,9] The benefits of students' interaction in multiple courses reflects their ability to develop a shared common language and the ability to apply what they learned from the various coursework.[2]

The existence of long term relationships during an academic program is valuable in developing a sense of community. Students who had prior interaction in online courses or interaction outside of the academic environment were more likely to support each other academically and emotionally.[7] Emotional factors such as feeling alone, fear, overwhelmed and anonymous negatively influenced the development of a sense of community in an online program.[9] In comparison, structural and process factors influenced the building of community in a positive manner.[9] Structure refers to the design of the course related to the mandatory participation in collaborative activities and the students' sense of contribution to the group work.[9] Structural factors need to be established before students focus on connecting with peers to develop interpersonal relationships.[2,8] Novice students spend more time conquering the structural challenges than on interacting with peers to build community; whereas, expert students devoted more time engaging with peers because they are already familiar with the precursor factors.[8]

Process factors also are important for developing community and are defined as actions strengthening the level of interaction by fostering student "confidence, motivation and learning."[9] The most important of these factors is the socialization process of becoming a self-directed learner and the progression from a novice to an expert online learner, thus enhancing students' confidence and self-efficacy.[9] Learning the rules of communication, including online etiquette, is part of creating a sense of community.[9] The process of accepting the "diversity of cyberculture" made up of students with common and dissimilar backgrounds is another important factor.[9]

Interaction facilitated the sense of community, as students and faculty engaged in shared discussions in the course. Formal interaction built connection, trust, self-confidence and learning among students.[9] Gaining trust and respect in the online environment was achieved through continual effort among participants as they assessed each other's strengths and ongoing support.[2,8] The development of community was fostered by community-minded students who made the online course a priority as evidenced by their active engagement in the discussions, respect for others, motivation and proclivity to know other students and to learn from each other.[8] Therefore, these students felt a connection to the community which in turn enhanced the level of community development and likewise, the higher level of community development influenced the students' connectedness.[8]

The purpose of this study was to explore the student perspective on the ebb and flow of learning communities in a graduate dental hygiene program. Educators who taught in the program noticed the development of community among many of the learners and thought it would be beneficial to examine the students' experiences of how this phenomenon occurred throughout the program.

METHODS AND MATERIALS

A qualitative case study method was designed to investigate the experiences of learners with communities in an online environment. The context for this case study was an online graduate program located in a northwestern U.S. university which awards a Master in Science degree in Dental Hygiene. Students attended a week-long on-campus orientation before beginning the core courses related to program devel-

opment and evaluation, special needs populations, leadership strategies, research and advanced dental hygiene theory. The program requirements included the selection of a specialty in dental hygiene education or community health. Each specialty area consisted of 2 didactic courses, 1 elective course and a practicum. A second week of face-to-face interaction on-campus was required for a seminar course with topics relating to practice, education and research. Students enrolled in the seminar to prepare for the research course and the subsequent thesis experience. All core courses and emphasis area courses were provided using an asynchronous format to accommodate the different time zones in which students lived.

The university's Internal Review Board approved the research protocol before participants were recruited. The purposive sampling method was employed to gain students representing a cross-section of progression in the program who were experiencing the phenomenon at different levels, as well as graduates who would be able to provide a retrospective view of the phenomenon. Personal interviews were conducted by a graduate of the Master's degree program after participants signed the informed consent form and selected a pseudonym to protect their confidentiality and anonymity. Participants received a copy of the interview questions 1 week before the in-person or telephone semi-structured interview. The audio data from the interview were recorded, transcribed and verified for accuracy before the second researcher analyzed the data.

The data were collected for the original purpose to determine the factors promoting and impeding the development and sustainability of online learning communities throughout the graduate program.[6] However, as these data were being analyzed, the researchers noted a pattern that evolved indicating the phenomenon developed in stages. As a result, all 17 of the transcripts were reanalyzed with the new purpose in mind. The first round of data analysis was conducted by deconstructing the data into initial codes representing the actions apparent in the data.[10] Initial codes were provisional, as a place to begin the analysis.[10] Open codes have the potential to change as the researcher uses the constant comparative method to determine similarities and differences in the data collected from multiple participants.[10] Therefore, each interview was analyzed and initial codes were compared to those established during the analysis of the other interviews.

The second round of data analysis and focused coding allowed the analysis to create conceptual categories that represented multiple open codes.[10] Throughout this process, the researcher wrote memos to raise questions about the analysis and relationships among the categories. The interviewer served as a peer reviewer to help answer the questions raised and determine relationships based on her experience in the program. In the third and final round of data analysis, the researcher focused on the relationships among the categories.[10] This relational analysis resulted in organizing the data into categories named as stages of online learning communities, subcategories reflecting supportive themes in each category and actions participants experienced in each subcategory.

After the data analysis was completed, the results written and a figure of the model developed, the validity of the analysis was verified by conducting member checks. Ten participants completed a review of this information to ensure the credibility of the researcher's interpretation of their experiences. In addition, 2 students who were in the online program, but not participants in the original study, were asked to read the results and provide feedback comparing their experiences in the program to the data analysis. Some comments made by the individuals about the fourth stage of the e-model from the first round of analysis caused the researchers to re-analyze the transcripts related to this final phase and develop a more accurate interpretation of the participants' experiences. A second member check was completed by current MS students who had completed 1 year of the program and graduates to provide feedback on the revised e-model. Nine individuals responded to the revisions in a positive manner and no additional changes were made to the analysis.

RESULTS

The participants lived in all regions of the U.S. (n=17). The entire sample was female; 2 students were in the first year of the program, 6 students comprised the second year level, 4 students from the third year level and 5 participants had graduated from the program.

The analysis of the qualitative data collected from the participants revealed 4 stages of online learning communities throughout the graduate program. Participants progressed through 3 stages of formal learning community development as they completed the core courses in the curriculum and 1 stage related to transmuting the community to an informal entity as students experienced the independent coursework in the program. The development of the formal learning communities followed 3 stages: Stage 1: Building a Foundation for the Learning Community, Stage 2: Building a Supportive Network within the Learning Community and Stage 3: Investing in the Community to Enhance Learning (Figure 1). The last stage was Stage 4: Transforming the Learning Community, which signaled a transition to an informal network of learners.

Figure 1: E-Model of Learning Communities

Table I: Subcategories and Actions of Stage 1 Building a Foundation for the Learning Community

Subcategories	Actions
Initial Connection	Meeting peers and faculty face-to-face at the on-campus orientation
	Connecting with new peers in online courses
Awareness of Online Learning Challenges	Appreciating the challenges of online communication
	Understanding the time commitment for online education
	Recognizing the challenges of the asynchronous online format
Online Learning Culture Socialization	Learning shared norms of interaction
	Establishing self-imposed performance standards

The first stage of community development, Building a Foundation for the Learning Community, revealed 3 subcategories and actions to achieve each subcategory (Table I). The Initial Connection was the first subcategory of Stage 1. The actions experienced by participants consisted of meeting peers and faculty face-to-face at the on-campus orientation, sharing common experiences during the on-campus visit and connecting with new peers in courses throughout the program.

Ella explained the importance of the face-to-face connections made during the on-campus orientation: "Spending the week to get to know everybody was very helpful so when we got into the courses you could put names and faces together and personalities as well. That was the starting point and the key to the whole community and the whole program because it helped you feel connected. The beginning orientation was the start, it really got us off on the right foot." Not all students attended the same orientation; some met for the first time in an online course. When students interacted in that environment it was suggested that "It should be a requirement that you put your picture on the discussion…. so when your postings show up, you can see who it is you are talking to. I think that is important" (Tango). Getting to know new students sometimes took longer as discussed by Online RDH, "Initially there were a couple of people who I felt that they were abrasive or a know-it-all, but once I got to know them, I realized they were not trying to be disrespectful. It did take longer by having not met them face-to-face and personally." Katy's perspective on becoming familiar with peers was, "We were figuring out personalities and after a while you knew who would write a book for each posting, who was the minimalist, who was the aggressive personality and who was the nurturer of the group. I liked this aspect because it was similar to a face-to-face group."

The second subcategory of Stage 1, Awareness of Online Learning Challenges, related to online communication, time commitment for course activities

and the asynchronous format. June lamented about the lack of visual cues when engaging in online communication, "The biggest problem with online communication is not having the body language and not being able to see how peers said something. For instance, you post something and it is interpreted different than the way you meant it." Sally shared her perspective of the time consuming nature of participating in the weekly discussions, "My challenge was being able to make postings and articulate the discussions without taking inordinate amount of time. I mean it took a lot of time even for a simple posting for me." The asynchronous format of course delivery presented other challenges as depicted by Katy, "When you post at the beginning of the week and another person doesn't post until Saturday, but it's due by Saturday night at 10 o'clock, then you are all stressed out because you want to respond, but is it going to be in time?"

The third subcategory of Stage 1 was Online Learning Culture Socialization. The actions experienced by participants included learning shared norms of interaction and establishing self-imposed performance standards in the online learning environment. Learning shared norms was possible during the program orientation, "The ground rules for communication and using the emoticons to help with what you say was stressed at the beginning and pretty much everyone follows those rules" (Ella). Another aspect of socialization involved the language used in the discussions as depicted by Patsy: "As time goes on, you learn the language of online communication." Furthermore, socialization included setting a collective standard for quality discussion postings was explained by Polly, "I don't think students in my class were very

comfortable doing one liner postings. When you are with your peers and you see they post in-depth, you feel motivated and an obligation or greater desire to post something in-depth as well. Reading those increased my desire to post and learn and post more." Establishing a self-imposed standard for interaction was articulated by Sally, "I felt I had a responsibility to the group as a learning environment to contribute with quality."

Stage 2 of developing the online community was Building a Supportive Network within the Learning Community. Three subcategories and corresponding actions were revealed from the interviews (Table II). Developing Interconnected Learner Relationships was the first subcategory of the second stage. Participants' actions included being open to developing relationships, establishing commonality and developing feelings of closeness and caring.

One action related to building interconnections among learners was being open to developing relationships, "It is up to the individual to take advantage of those opportunities for interaction. I mean we all live in communities physically, but we never know our neighbors unless we do our part, unless we extend ourselves to learn from them and learn about them. The opportunities are there and it's up to us" (April).

Informal activities during the on-campus orientation visit were recognized as contributing to establishing common experiences with peers, as Whiskey indicated, "The outside of school interaction where you play and perhaps be a little naughty. It separates the student personality from the real person personality, who we are professionally and who we are as a student and who we are when we are kicking back and walking around in our underwear. It was a good interaction. Especially that first visit because we were just getting into the program and you have a bunch of scared students and they're telling their worries to each other." Katy expressed her thoughts on commonality: "Everybody was interested in what everyone else was doing and everybody knew everyone understood teeth and everybody was juggling many roles from teaching to families. We were on the same page with everything. We were in the same situation and we could talk to each other and work things out together."

Feelings of closeness were voiced by Sally, "I consider myself as a member of a family and from my perspective it was definitely as a class" and Tango discussed feelings of caring, "We were not afraid to be personal and to share experiences because we knew we were sharing them with people who cared." These feelings of being connected were developed "by sending personal emails, making phone calls and by sharing, calling and asking how are you doing or

Table II: Subcategories and Actions of Stage 2 Building a Supportive Network within the Learning Community

Subcategories	Actions
Interconnected Learner Relationships	Being open to developing relationships
	Establishing commonality
	Developing feelings of closeness and caring
Network Support for Learners	Experiencing a safe learning environment
	Developing trust through positive interaction with peers and faculty
	Receiving support from peers
Fellowship	Developing competence in the online learning environment
	Being an individual contributor to community learning

sharing progress and asking about how your family was or how things were going" (Patsy).

The second subcategory of Stage 2, Network Support for Learners, related to the actions of experiencing a safe learning environment, developing trust through positive feedback from peers and faculty and receiving support from peers. A safe learning environment was conceptualized by Patsy, "The online community has to be a safe place where people can express their opinions" and Online RDH, "I never feel attacked ever in any way. Sometimes my opinions would be disputed, but it was always very professional and respectful." A supportive network provided positive feedback as explained by Ella, "Good honest constructive feedback from both the instructor and peers probably is the most important thing in creating an environment that fosters learning." Penelope expressed a growing dependence on the supportive network as time went on, "It's just nice to get a pat on the back and say hey, you did good…I'm becoming more dependent on the community support than I was initially." The peer network was a resource for receiving help with technical problems and questions about courses and receiving emotional support as portrayed from the following quotations:

Steel Magnolia: "When I had questions that I needed answered, most all the time it was another student who would jump in and help me or explain things to me before the teachers even got to me."

Whiskey: "It's nice having the community feel to the learning because truly they're the only ones who know what you are going through. Your family can be supportive, but they don't understand really what you are going through. They [peers] are the only

ones who can keep you going because they understand."

The last subcategory of Stage 2 was Fellowship, as participants began to experience learning as being a member of the community through the actions of developing competence in the online environment and being an individual contributor to community learning. Steel Magnolia illustrated her progress from Stage 1 to Stage 2 whereby she developed competence, "It was a learning curve for me at first because I had to get in the flow of learning online classes, getting used to the postings and the discussions was something that took some time, but eventually grew and flushed it out so that I felt very comfortable and competent at it" and her experience being a contributor, "During the leadership class a lot of my experiences helped others. They were interested in some of the stuff I had been doing and it was beneficial to them. I felt like I really contributed to something to their experience."

The third stage of online community development constructed from the data was Investing in the Community to Enhance Learning. This stage revealed 2 subcategories, Collaborative Interaction and Synergy Creation and 2 actions within each subcategory (Table III).

The first subcategory of Stage 3 was Collaborative Interaction. The actions experienced by participants were committing to community learning and actively learning from each other. Online RDH explained commitment, "An effective learning community involves people who are committed, who prepare by reading and reflectively thinking and then bringing their preparations and thoughts to the table for everybody's discussion." Bluthner elaborated further, "We try to apply ourselves to what we read in the previous post that can advance the topic" and "If you have a supportive online group, together we are working towards a similar mission. There is camaraderie and bonding in that and it provides a big source of motivation." Actively learning from each other was discussed by Irma, "Part of this online program is the value or learning from your peers … It was valuable to hear and learn about what people were doing versus just reading about it in a book." Steel Magnolia's perspective was, "The experience wouldn't have been half as enriching without the other people and without the instructor … When people help each other out and share their diverse knowledge that builds community. When they come from different backgrounds and give their input and experience, it broadens the experience for everyone."

The second subcategory of Stage 3 revealed from the data was Synergy Creation. The first action in the synergy subcategory was developing a higher connection among peers from an interpersonal and

Table III: Subcategories and Actions of Stage 3 Investing in the Community to Enhance Learning

Subcategories	Actions
Collaborative Interaction	Committing to community learning
	Actively learning from each other
Synergy Creation	Developing a higher connection among peers
	Constructing knowledge as a community

intellectual perspective. Steel Magnolia shared her experience with developing stronger relationships, "I have been interacting with these people for over 2 years so they became a part of my life and are part of my graduate experience. We do develop a relationship even though it's not a 1-on-1 or face-to-face one. We definitely, over time, build the relationship and it evolves." Online RDH confirmed relationship building by stating, "We all got closer by the end of the core courses. Our relationships absolutely changed….Relationships definitely did grow and progress throughout the curriculum." Whiskey shared her viewpoint, "Discussions are definitely less formal, but there is a higher connection. There has been growth intellectually [over the semesters] and our critical thinking is advanced for sure….It's a sense of enlightenment." The attainment of this level of community development was explained by Bluthner, "My definition of an online learning community is learners who are passionate about their profession and their educational journey, who also…value the peer learning process and providing a synergistic positive energy environment."

A sense of constructing knowledge as a community was articulated by Polly "I felt we all learned things together. We all reaped the knowledge together and then we could share it with each other. We could discuss the new things we all learned together and bounce ideas off of those new ideas and share ideas from that new knowledge." Bluthner added, "From the aspect of an individual learner, we each need to become active with the material, read it, analyze, synthesize and develop from that process ... As a community learner you can learn so much more after each person has shared what their perspective is or what they learned can be clarified and your perspective has been broadened. Deeper levels of understanding occur with community learning." Polly explained further, "Peers influenced my learning when you had more in-depth postings where you get more information and ideas you have to ponder. It makes you open to everyone when you realize there is an endless amount of ideas to help problem solve. It adds up to a higher level of knowledge and it's stim-

ulating too. When you are stimulated, it opens up your mind and you are motivated to learn more." The concept of synergistic learning in the community was expressed by Sally, "All of the input from the individuals seemed like the group experience was overall greater than each person's individual part. We created something unique."

The last stage in the online graduate program was Transforming the Learning Community (Table IV). The final stage's subcategorieswere Absence of the Formal Peer Network, Construction of an Informal Learning Community and Adaptation of the Informal Learning Community.

As students engaged in independent learning experiences in the practicum and thesis courses at the end of the graduate curriculum, the peer network formerly established during the completion of the core courses was absent. Students did not interact with peers on a regular basis and some students felt isolated. The lack of peer interaction was viewed as "It's like you're cut off from this group of friends. You miss the discussion boards. You miss getting online and having that connection once a week" (Patsy). The lack of a supportive network "lowered my motivation for learning because I don't have others to connect with. You can't support each other" (Polly). Isolation was articulated by Teeth Geek, "It does feel isolated at first and a little sad because what was initially scary when beginning the online program and learning so much in an unfamiliar format became the blossoming of new relationships and sharing wonderful learning experiences with a group of peers who uniquely understood because they were having similar wonderful experiences and celebrating those successes together. Then, suddenly being without them, this was a little hard to get used to." However, Teeth Geek elaborated further as she reflected on this experience during a member check, "Because of the strength of the first 3 stages, I was able to use that synergy to get me through the initial 'loneliness' of the fourth stage and positively focus on the work at hand [in thesis]."

This feeling of isolation spurred some students to experience a Construction of an Informal Learning Community as they reconnected to peers through informal communication mechanisms as Katy indicated, "After I realized I wasn't getting enough peer support, I started talking to several peers on the phone and communicating via email or Facebook." Re-establishing a supportive network was evident from Pasty's comment, "One person who was in thesis with me, we taught each other and we sat together on the phone across the United States." June offered her perspective on a supportive peer network, "Hopefully you will have someone who's also going through thesis and then you can help each other and encourage one another and support one another....

Table IV: Subcategories and Actions of Stage 4 Transforming the Learning Community

Subcategories	Actions
Absence of the Formal Peer Network	Not interacting on a regular basis
	Feeling isolated
Construction of an Informal Learning Community	Reconnecting with peers through informal communication
	Re-establishing a support network
Adaptation of the Informal Learning Community	Struggling out of the chrysalis (Finding your wings)
	Maintaining lifelong relationships with peers and faculty
	Forming new learning communities

It is nice to be able to confide in one another and it would be great to stay connected with them. It's important just to keep you motivated and help you realize there is a light at the end of the tunnel."

The last subcategory of the final stage was Adaptation of the Informal Learning Community. Teeth Geek explained her experience with struggling out of the chrysalis, "I began to realize that thesis is a chance to give back to future generations and is an important step in becoming the kind of educator, researcher, professional and mentor who facilitated the great experiences you've had during your MSDH journey. It is necessary to 'struggle out of the chrysalis' needed to find your own wings." Maintaining lifelong relationships with peers and faculty was evident as some peers continued to interact after graduation, "I did have the opportunity to run into several of my classmates [now graduated] at the ADHA national convention and sometimes I run into them at the national oral health conference" (Tango). Furthermore, new informal learning communities were created after graduation as experienced by Tango, "I definitely participate in public health listservs so I do read those and participate in those and of course I peek through my ADHA district listservs. So it's a vast online community that I have."

DISCUSSION

The creation of the 4 stage e-model resulted from the inquiry of the online learning community phenomenon experienced by dental hygiene students in a graduate program using a cross-sectional approach to data collection. The data analysis revealed an e-model consisting of 3 stages representing a crescendo in the development of formal learning communities, while the last stage described the formation of informal learning communities and lifelong collegial relationships. Formal learning communities

were created over the semester time frame in the core courses of the graduate program during the interaction required of learners in the weekly discussions or activities. Informal community development was necessary when learners progressed to the independent course experiences, practicum and thesis courses, in the graduate program and no longer participated in required weekly discussions. Informal communication through back channel means (e.g. telephone calls, email, social networking sites) was vital for re-establishing a supportive network within the program and beyond graduation.

The e-model extends the understanding of online learning communities as presented by Brown.[8] Stages 1 to 3 of the e-model are similar to Brown's stages of meeting, membership and camaraderie. The similar findings might indicate a need for prolonged, intense or face-to face engagement among learners to reach higher levels of learning communities. Brown studied novice and veteran online learners who were enrolled in a graduate course during the fall, spring and summer sessions presented in an asynchronous fashion. However, participants in the e-model study represented a cross-section of progression in an entire graduate degree program and graduates who had a retrospective view of learning communities. In addition to the asynchronous core courses, the graduate program required 2 on-campus visits where students had the opportunity to connect face-to-face with peers and faculty. These differences might explain the development of Stage 4: Transforming the Learning Community, which adds an additional phase to understanding learning communities within an online graduate degree program.

The e-model was represented by 3 interrelated key elements over the course of the graduate degree program: metamorphosis of relationships, metamorphosis through the affective domain and metamorphosis through the cognitive domain. The developmental progression through each of the 3 key elements was necessary to reach the highest level of each key element.

Figure 2 depicts the hierarchy of relationships as students progressed through the graduate program. Each level represents a developmental change in the quality of relationships. At the simplest level, establishing the initial connection during the on-campus or online meet and greet laid the foundation for connecting to other learners in the community in Stage 1 of the e-model. During Stage 2, learners developed a close and caring relationship, which in turn created a network of interconnected learners portrayed by feeling safe, trust and support for each other. These experiences were important for the development of fellowship portrayed as a supportive network of equals. When learners evolved to the status of being an equal in the learning community this achievement

Figure 2: Key Element: Metamorphosis of Relationships
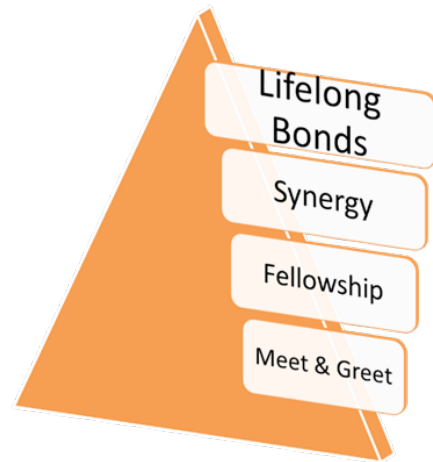
was influenced by their ability to overcome the challenges in the online environment, develop competency in becoming an online learner and participate as a valuable contributor to learning. The fellowship level of relationships is where students developed self-efficacy as an online learner and established an authentic connection with community members.

The highest level of relationship development within the formal learning community was the synergistic relationship revealed in Stage 3 of the e-model. This relationship involved the ability of the members to cooperate and collaborate based on the enhanced quality of the interconnected relationships developed through ongoing interaction in the core courses. Students involved in a synergistic relationship were united by working towards accomplishing a common goal and felt the freedom to share their insights for the benefit of the collective group. Synergistic relationships were characterized by the positive energy created by the interconnected learners. Lastly, lifelong bonds were characteristic of an informal learning community established in Stage 4 where peers and faculty formed collegial relationships that extended beyond graduation.

Social interaction is an important aspect of learning and is based on the social constructivist theory.[11] The constructivist model is applicable to traditional learning contexts and online situations.[5] Specific to online learning, social presence is one of the 3 key components of the Community of Inquiry model.[12] Social presence is created by conveying a sense of a real person through affectively expressing oneself, openly communicating and developing a group identity.[12] The e-model created from this current inquiry points to a developmental process of relationships, each stage building on the other, in a similar fashion as Brown's model.[8] Her level of "membership" characterized by reaching the status of being a contributor to the discussions and others building on

those ideas[8] is similar to the level of "fellowship" experienced by the dental hygiene graduate students. However, the e-model differs from Brown's model, in that "camaraderie" through making interaction a priority was analyzed as an affective change in the learners' values in the e-model. Synergistic relationships in the e-model had a strong affective dimension, which related to learners valuing each other, caring about and empathizing with their peers and providing encouragement to each other. Likewise, the positive energy created by synergistic relationships influenced the synergistic cognitive development of the community.

The literature on women's learning supports the interconnectedness of relationships, affective development and cognitive development. The significance of relationships to females was first recognized by Gilligan's research on the moral development of women. At the highest level of maturity, women had an ethic of care characterized by valuing the importance of interpersonal relationships based on collaboration and cooperation and being responsible and sensitive to others.[13] Belenky and associates built on Gilligan's findings to explain "women's ways of knowing."[14] These researchers identified "connected knowing" as one way women learn.[14] Connected knowing is subjective because it requires the leaner to empathize and share another person's experiences, trusting what others are saying and learning from others' perspectives.[14] This way of knowing requires an affective component of feeling connected to the learning.[14] Participation in discussions and collaboration in the online learning environment nurture the use of connected knowing within the learning community.[15]

More recently, social capital and supportive networks have been identified as important factors for women's learning. According to social capital theory, social networks are viewed as investments in relationships.[16] This investment can be considered capital to earn a profit, which can be redeemed at a future time to advance any individual's interests who participated in the relationship.[16] Learner relationships within networks are built on collaboration, trust, mutual respect, shared values and shared norms.[16] Social capital built on supportive networks is used to improve student success in graduate programs.[17] Interaction with peers and faculty within a graduate program provide formal and informal network systems. These systems provide an opportunity for academic and emotional support as students share a common purpose of earning the graduate degree.[17]

Emotional support within the online learning environment was revealed as an important factor in the development of relationships in the e-model. Within the online context `emotions can affect the learner in a positive or negative manner.[18-20] Emotions have

Figure 3: Metamorphosis through the Affective Domain[24]

been reported in each presence within the Community of Inquiry Model: social, cognitive and teaching.[21] More recently the emotional component has been proposed as a separate entity from the other presences; thereby, adding a fourth presence to the Community of Inquiry Model.[22,23] In comparison and in addition to emotions and feelings, the e-model exposed a developmental change in values, priorities and actions guided by an internal values system within the affective domain.

The second interrelated key element in the e-model consists of the metamorphosis through the affective domain of online learning communities (Figure 3). Krathwohl et al created a hierarchy of emotions, values and beliefs, from the simplest level to the most complex.[24] The simplest level, receiving a phenomenon, was revealed as the novice graduate students engaged in online activities and developed an awareness of the learning community phenomenon by interacting with peers and faculty. This level also involved becoming conscious of the online culture and its rules of communication and standards of performance. Students entered the next level of the affective domain, responding to the phenomenon,[24] when they actively engaged in the learning community by applying the cultural norms, being open to developing relationships and being satisfied with their contributions to learning. Valuing the phenomenon, the third level of affective development,[24] was evidenced by students attaching a worth to the online community, demonstrating a belief that collaborative learning was important and committing to the community as an investment in their learning. Furthermore, the valuing level was important for believing that peers' and faculty's diverse experiences provided enriched opportunities for learning beyond the knowledge gained from textbooks. A community placing value on commitment enhanced motivation of its members.

The fourth level in the affective domain required

students to organize values into priorities and create a unique values system.[24] Prioritization involved spending time and effort in preparation for in-depth postings and collaborative interaction. The unique values system related to the emphasis on synergistic learning, which inspired and aroused excitement in the enhanced status of learning achieved by the community. Characterization was the most complex level of emotions, values and beliefs requiring students to internalize the value of a phenomenon, thereby guiding their actions.[24] Internalization of the value of the formal learning community directed the learners' actions to establish informal learning communities when they felt isolated during the independent learning courses in the graduate degree program. The students' ability to establish and adapt to an informal community resulted from their feelings of being comfortable, competent and stimulated from the collaborative learning that occurred in the formal communities. It seems likely that the learners' previous experience was positive and they desired to continue these values and emotions in new situations.

The third interrelated key element of learning communities was the metamorphosis through the cognitive domain (Figure 4). The hierarchy of knowledge shown in the figure was originally developed by Bloom and colleagues in 1956 and was revised in 2001 by Anderson and Krathwohl.[25] The simplest level of cognitive domain involves remembering information; whereas, the creating level requires the most complex functioning.[25] The core courses of the graduate program focused student outcomes at the analyzing, evaluating and creating levels. During the pinnacle experiences of the learning communities in these courses, synergistic learning was apparent, which coincided with the creating level. Synergistic learning was experienced as the creation of innovative knowledge unique to a collaborative group. This knowledge was built from intensive interaction of the group to outperform the sum of abilities of each individual member. Synergistic learning was the positive energy stimulating the collective construction of ideas both quantitatively and qualitatively. This learning enhanced the level of student performance based on the interaction with synergistic relationships and affective actions.

The concept of synergistic learning is supported by Zhu and colleagues who proposed a synergistic learning model as a new framework to explain learning in a technology-based system.[26] This learning was characterized by "deep interaction between content and learners," information sharing, collaborative and cooperative construction of knowledge and "collective thinking."[26] Within the technology system, the interaction of 5 fields comprises the learning field: information, knowledge, behavior, emotion and value.[26] It is interesting to note the separation of

Figure 4: Metamorphosis through the Cognitive Domain

Figure 5: The Interrelationship Among the 3 Key Elements
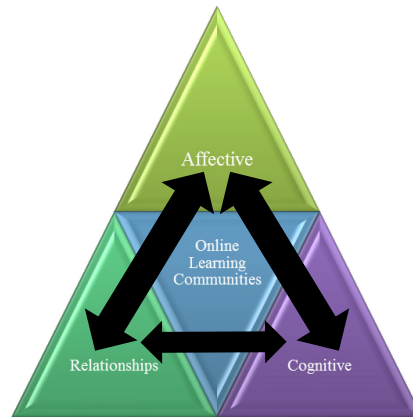
the emotion from the value field and the inclusion of both within the process of synergistic learning, which corroborates the findings related to the e-model.

The 3 key elements of online learning communities are: metamorphosis of relationships, metamorphosis through the affective domain and metamorphosis through the cognitive domain. These were interrelated based on the experiences of students enrolled in an online graduate program. Each element was mutually related to the other 2 elements as shown in Figure 5. Students who reached the higher levels of each hierarchy experienced a relative developmental change in the other hierarchies. Perhaps the most significant finding was the essential role the affective domain had in influencing the metamorphosis of relationships and the cognitive domain.

This qualitative inquiry on the phenomenon of online learning communities over the length of a graduate degree program adds an e-model to the scientific body of knowledge in dental hygiene education. The e-model describes a 4 stage process through which

learners experience a metamorphosis in their affective, relationship and cognitive development.

Students' experiences in Stage 1: Building a Foundation for the Learning Community, provided the groundwork for learners to progress to Stage 2: Building a Supportive Network within the Learning Community. Advancement to Stage 3: Investing in the Learning Community was facilitated by the experiences in Stage 2. The final stage was Transforming the Learning Community to an informal network of colleagues as students completed the curriculum and focused on their personal professional development and anticipated careers. The e-model represents the ultimate experience with learning communities in a graduate program. Learners advanced through the stages at different rates; however, it was difficult for students who remained independent learners to progress to Stage 3 and 4 as they did not value being open to building relationships and creating knowledge as a collective community.

The most influential key element contributing to the learners' evolution through the e- model was the affective component. The affective development generated informal learning communities from the value of formal learning communities. Lifelong collegial relationships extending beyond the academic program were formed. Synergistic learning in the cognitive element was possible based on the interaction between synergistic relationships and affective actions.

Although the e-model and 3 key elements of online learning communities is based on female graduate students from one dental hygiene program, the findings provide a foundation on which future investigations can be based. The importance of continuing this line of investigation is paramount as distance education links the global dental hygiene community during the pursuit of master and doctoral degrees. Furthermore, Lock suggested that educators need to examine this phenomenon in a broader context, beyond the academic institutional setting to the global community of professional associations and "professional thinking."[27]

CONCLUSION

Online graduate programs present many challenges to students; however, engaging in formal and informal learning communities provide the means to being productive learners. Students struggle through their coursework, but when they have the support of learning communities and develop competence and confidence navigating these challenges, they can be successful. Learning communities are similar to the chrysalis in which the butterfly develops fully surrounded by a supportive structure. The butterfly must struggle out of the confining chrysalis as a necessary process to build strength in its wings in order to fly. Learners also must struggle to emerge from the chrysalis, to strengthen their wings to fly and to begin new lives as independent, self-motivated and self-sufficient professionals.

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DISCLOSURE

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Relationship of Musculoskeletal Disorder Pain to Patterns of Clinical Care in California Dental Hygienists

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Abstract

Purpose: To relate self-reported levels of musculoskeletal disorder (MSD) pain and patterns of clinical care among members of the California Dental Hygienists' Association (CDHA), using a web-based survey.

Methods: The 24-item survey consisted of questions on patterns of clinical care, health habits, experience with MSD pain and demographic information. Recruitment information, including survey link and consent form, was emailed to the CDHA for distribution to its members. Descriptive analysis and cross tabulations were conducted using the online software program Qualtrics™. A Chi-square test determined statistical significant differences between the responses of the no/mild pain and moderate/severe pain groups.

Results: The response rate was 19% (500/2,700). Ninety-six percent of all respondents reported some level of MSD pain, causing nearly 25% of the respondents to miss work. Respondents, who reported moderate/severe pain, treated more patients per day (p=0.007) and on average treated greater numbers of moderate to heavy calculus patients (p=0.017) than those respondents reporting no/mild pain. Forty percent of the respondents in the moderate/severe group treated more than 8 patients per day. A higher percentage of respondents (p=0.000) in the moderate/severe pain group than in the no/mild group reported using proper posture less than 50% of treatment time. Using proper posture more than 50% of treatment time was more frequent in respondents who had practiced more than (p=0.012), compared with less than, 5 years.

Conclusion: Workload and ergonomics are related to MSD pain. Educational programs need to emphasize the importance of these factors in the development and reduction of MSD pain.

Keywords: dental hygienists, back pain/etiology, musculoskeletal disease/etiology, occupational disease/etiology, risk factors, dental scaling/adverse effect, hand/pathology, prevalence, pain/epidemiology

This study supports the NDHRA priority area, **Occupational Health and Safety:** Investigate the impact of exposure to environmental stressors on the health of the dental hygienist (aerosols, chemicals, latex, nitrous oxide, handpiece/instrument noise).

INTRODUCTION

Work-related musculoskeletal disorders (MSD) are common in practicing dental hygienists, as well as dental hygiene students.[1-8] Most MSD adversely affects the upper and lower back, neck, shoulder, arm, hand and wrist, causing pain.[9-11] Even at optimal seating positions more than 50% of the body's muscles are contracted allowing very little movement in the vertebrae.[10] This muscle contraction can lead to micro traumas to the bones, joints, muscles, ligaments, nerves and blood vessels.[10,12] Studies have shown that MSD pain in the back and neck was related to exposure to static postures and vibration in the workplace.[4,9,12-16]

The physical burden of clinical dental work is shown to be strongly associated with MSD pain.[3] MSD is not due to a single incident, but rather develops over time through repetitive, forceful or awkward movements and positions in the workplace.[2,12] The symptoms of MSD may present as burning, tingling, numbness, swelling, limited motion or pain in the back, neck, shoulder, arm, hand, and wrist.[2]

One-third of the time that dental hygienists miss work was found to be due to pain caused by MSD.[2] It has been suggested that MSD pain in dental hygienists may be a major cause of sick leave, decreased productivity during work and the possibility of disability or early retirement from the profession.[4,5,11]

While MSD is known to be associated with work-related pain in dental hygienists, more research is needed to identify patterns of clinical care that may be the major contributing factors in MSD pain. The purpose of this quantitative study was to investigate the relationship between self-reported levels of MSD pain and patterns of clinical care among dental hygienists who are members of the California Dental Hygienists' Association (CDHA).

METHODS AND MATERIALS

This cross-sectional study was approved by the University of California San Francisco (UCSF) Institutional Review Board. The study population was ac-

tive voting members of the CDHA, for whom CDHA had email addresses.

The survey was developed based on review of the current literature. The survey was critically pre-tested for feasibility and acceptability by 5 licensed dental hygienists, excluded from the survey. Following the review, the survey was modified accordingly.

The 10-minute survey consisted of 24 items in the following domains: patterns of clinical care (12 multiple-choice questions), health habits (2 multiple-choice questions), experience with MSD pain (6 multiple-choice and 1 Likert-like-scale statements) and demographic information (3 multiple-choice questions).

The study was implemented using the UCSF on-line survey software program, Qualtrics™. The recruitment letter explaining the study and providing the survey link, as well as the informed consent form, was sent to the CDHA for distribution to its members. Two weeks later, CDHA sent 1 follow-up email message to all its members with a disclaimer stating that if they had already completed the survey to disregard the notice. Participants' response to the survey implied informed consent.

Qualtrics™ software calculated the frequencies of responses for each survey item. An overall pain score was calculated by adding each respondent's self-reported pain on a scale of 0 to 4 for each of the following 8 areas: neck, shoulder, upper back, lower back, hips, arms, wrist and thumb. This score was derived from having the respondents rate their pain from 0 to 4 with 0=no pain, 1=mild ache not noticeable without stopping to think about it, 2=definite ache that makes you consciously uncomfortable, 3=ache that causes you to pause or discontinue treatment of a patient, and 4=numbness and/or tingling. The sum of the ratings of each area represented the overall pain score, with a potential range of 0 to 32. Based on the pain score, respondents were divided into 2 groups: no/mild pain (0 to 8) and moderate/severe pain (9 to 32). The Chi-squared test was conducted to compare the responses of the 2 groups. A p-value <0.05 was used to determine statistical significant differences between the 2 pain groups.

RESULTS

Of the approximate 2,700 active voting members of the CDHA, 500 members responded, resulting in a response rate of 19%. Because 12 surveys were completely blank, results are based on 488 respondents. Nearly half the respondents were born between 1950 and 1969 (49 to 64 years of age) (Table I). Respondents were mostly female and Caucasian (non-Hispanic). The majority of respondents were

Table I: Characteristics of Study Sample (n=488)

	n	Percent of Rrespondents
Years of birth		
1940 to 1949	60	13
1950 to 1959	125	27
1960 to 1969	106	22
1970 to 1979	60	12
1980 to 1989	107	23
1990 to 1999	13	3
Gender		
Female	468	97
Male	14	3
Race/Ethnicity		
African American	6	1
Asian or Pacific Islander	46	10
Caucasian (Non-Hispanic)	370	77
Hispanic or Latino	38	8
Other	22	5
Currently practicing clinical dental hygiene		
Yes	415	86
No	67	14
Years practiced		
0 to 2	78	16
3 to 5	58	12
6 to 9	44	9
10 or more years	303	63
Days per week practiced		
1 to 2	93	19
3 to 4	316	65
5 to 7	79	16
Hours per day practiced		
1 to 3	5	1
4 to 6	27	5
7 to 8	411	85
>8	43	9
Patients treated per day		
<8	317	66
>8	164	34
Minutes per appointment		
15 to 30	15	3
31 to 45	46	9
46 to 60	420	86
>60	6	1

Table II: Respondents' Patterns of Practice: Comparison of the No/Mild and Moderate/Severe Pain Groups of Respondents

Patterns of Practice	No/Mild Pain		Moderate/Severe Pain		p-value
	n	Percent of Respondents	n	Percent of Respondents	
Years of birth					
1940 to 1949	40	14	20	11	0.240
1950 to 1959	85	29	40	22	
1960 to 1969	58	20	48	27	
1970 to 1979	40	14	20	11	
1980 to 1989	62	21	46	26	
1990 to 1999	7	2	6	3	
Years practiced					
0 to 2	49	16	32	17	0.530
3 to 5	36	12	24	13	
6 to 9	26	9	17	9	
>10	192	63	112	61	
Days practiced					
1 to 2	66	22	27	15	0.095
3 to 4	186	61	130	70	
5 to 7	51	17	28	15	
Hours per day practiced					
1 to 3	2	1	3	1	0.440
4 to 6	16	5	11	6	
7 to 8	260	86	151	82	
>8	23	8	20	11	
Patients treated per day					
<8	213	71	111	60	*0.007
>8	88	29	74	40	
Minutes per appointment					
15 to 30	6	2	9	5	0.140
31 to 45	30	10	16	9	
46 to 60	264	87	156	84	
>60	2	1	4	2	
Average amount of deposits					
<light-moderate	225	75	118	64	*0.017
>moderate	77	25	66	36	

Sample sizes varied
*Significant differences between the two groups (p <0.05)

currently employed as clinical dental hygienists, and most have worked for 10 or more years. Most respondents indicated that they practiced 3 to 4 days per week, 7 to 8 hours per day and treated 8 or fewer patients per day, with 46 to 60 minute appointment times (Table I).

Ninety-six percent of the respondents reported suffering some level of pain. A quarter of the respondents reported having taken time off work due to MSD pain, and 53% of them reported taking 1 to 2 days off work per month.

The pain scores of the respondents ranged from 0 to 29 out of a possible 32 with the mean of 7, median of 7 and a mode of 3. Based on the pain score,

292 to 303 respondents were in the no/mild pain group, and 180 to 185, in the moderate/severe pain group. The numbers per item varied due to not all respondents answering all questions.

The majority of respondents, reporting moderate/severe pain, exhibited similar patterns of clinical practice as the total group: practiced for 10 or more years, 3 to 4 days per week, and 7 to 8 hours per day; treated 8 or less patients per day for 46 to 60 minutes; and mainly patients with light-moderate to moderate amounts of calculus (Table II). Forty percent of the respondents, reporting moderate to severe pain, treated more than 8 patients per day. Furthermore, the percentage of respondents in the moderate/severe pain group who treated more than 8 patients per day was significantly higher (p=0.007) than the percentage in the no/mild pain group. Also, the frequency of respondents with moderate/severe pain, who treated patients with greater than or equal to moderate amount of calculus, was significantly greater (p=0.017) than those with no/mild pain (Table II). Age, determined by decade of birth, was not related to moderate/severe pain.

The neck was the most common location of moderate/severe pain in respondents in the moderate/severe pain group (Table III). Moderate to severe pain in the shoulder, upper back and lower back was also reported by nearly one-third of these respondents (Table III).

Most respondents in both the no/mild and moderate/severe pain groups used the ultrasonic instrument for less than 50% of the appointment and wore magnification lenses or loupes for more than 4 hours per day (Table IV). A higher percentage of those reporting no/mild pain indicated they exercised more than 3 days per week, whereas the percentages of those with moderate/severe pain, who exercised less than and more than 3 days per week, were fairly comparable (Table IV). Using proper posture during clinical care greater than 50% of the treatment time was reported by the majority of those with no/mild pain, but only by half the moderate/severe pain group (Table IV). The difference between these 2 groups was significantly different (p=0.000).

A significantly greater percentage of respondents (p=0.012) who have practiced more than 5 years reported using proper posture during clinical care greater than 50% of the treatment time, as compared with those who have practiced 5 or less years (Table V).

Over half of the respondents reported that they had sought treatment for their MSD pain. Over 25% reported being referred to a chiropractor. Additional

Table III: Body Region of MSD Pain in the Moderate/Severe Pain Group of Respondents

Location	Moderate/Severe Pain Respondents	
	n	Percent
Neck	162	41
Shoulder	169	35
Upper Back	145	30
Lower Back	143	30
Hips	84	18
Arms	94	20
Wrist	101	22
Thumb	117	25

recommended treatment options were taking time off work, referral for an MRI, CT scan or X-rays, or referral to a specialist. Half of the respondents indicated other types of treatments, and specified the recommendations which they had received. Twenty-five percent specified physical therapy. Nearly half of the respondents received recommendation for a combination of two or more of the treatment options.

DISCUSSION

This study examined the relationship of self-reported MSD pain and factors associated with patterns of clinical care among active, voting members of the CDHA. MSD pain was found to be a major problem in practicing clinical dental hygienists, as almost all the respondents reported having some level of pain. Other studies also have demonstrated this occupational risk.[1-8] Nearly a quarter of the respondents reported taking days off work because of MSD pain. This finding supports other studies that state MSD pain is a major cause of dental hygienists' taking time off work.[8,17]

The results indicated that workload was related to MSD pain: respondents, who reported moderate/severe pain, treated significantly more patients per day than those respondents reporting no/mild pain, and 40% treated more than 8 patients per day. This relationship is consistent with studies in the literature: dental hygienists working increased hours had more wrist pain, compared to those practicing less hours,[12] and dental hygienists had more shoulder pain when working more than 4 days per week and had greater wrist/hand pain when their duration of work increased.[13] Another major predictor of pain in this study was the average amount of calculus deposits on the respondents' patients: heavier deposits related to more pain. These finding may indicate that applying greater force when trying to remove

Table IV: Use of Ultrasonic Instruments, Loupes, Proper Posture and Exercise by Respondents: No/Mild and Moderate/Severe Pain Groups

	No/Mild		Moderate/Severe Pain		p-value
	n	Percent	n	Percent	
Ultrasonic instrument use					
≤50% of appointment	257	85	148	80	0.122
>50% of appointment	44	15	37	20	
Loupes use					
≤4 hours	109	36	62	34	0.573
>4 hours	192	64	122	66	
Proper posture use					
<50% of appointment	90	30	96	52	*0.000
>50% of appointment	211	70	89	48	
Exercise					
<3 days/ week	118	39	85	46	0.143
>3 days/week	183	61	100	54	

*Significant differences between the 2 groups (p<0.05)

heavy deposits of calculus may lead to more pain. Accordingly, a correlation between the number of heavy calculus patients and symptoms of carpel tunnel syndrome has been reported.[13]

The use of ultrasonic scalers versus hand scaling on patients with heavy deposits was not addressed in this study. However, it is interesting to note that 36% of the moderate/severe pain group reported their average amount of deposits being moderate, while the percentage using ultrasonic scalers >50% of the appointment was only 20% of these respondents. This may indicate that not all in the moderate/severe pain groups may be maximizing the use of ultrasonics on patients with heavy deposits. Using ultrasonics on patients with heavy deposits may prevent or minimize MSD.

The predominant locations of MSD pain in the moderate/severe group of respondents were similar to those in dental hygiene students, reported by Hayes et al.[4] These researchers reported that in 3 classes of students the prevalence for MSD pain, defined as persistent greater than 2 days and comparable to moderate/severe pain, was, as follows: neck (44 to 46.3%, lower back (39 to 46%), shoulders (29.3 to 32%) and upper back (22 to 34.1%). These percentages for specific body regions were similar to ours for practicing dental hygienists. Morse and colleagues compared dental hygiene students, dental hygiene students with prior experience as dental assistants and experienced dental hygienists in terms of prevalence of MSD in the neck and shoulder.[18] In those 3 populations neck symptoms were reported as 37%, 43% and 72%, respectively. Shoulder symptoms were 11%, 20%

Table V: Use of Proper Posture Related to Number of Years Practicing as a Dental Hygienist

	Correct posture used >50% of treatment		
	n	Percent	p-value
Practiced <5 years	75	25	*0.012
Practiced >5 years	227	75	

*Significant differences between the 2 groups (p<0.05)

and 35%, respectively. In the current study, the percentage for shoulder pain was comparable to the data for practicing dental hygienists, but lower for neck pain (41%).

Morse and colleagues also studied risk factors in the same 3 populations.[18] They demonstrated statistically significant stepwise progressions for these risk factors: often or very often working with a bent or twisted neck, static posture (holding same position, unsupported), precise hand motions, and hand/arm repetition. These risk factors support the findings that a higher percentage of respondents with more pain reported that they used proper posture less than 50% of the time. Poor posture during clinical procedures often occurs when the dental hygienist tries to avoid indirect vision, causing forward trunk flexion and shoulder elevation.[13] Poor working position is thought to be the main risk factor for MSD pain according to the results of Marklin and Cherney.[19] In addition, the current study found

that respondents, practicing more than 5 years, used proper posture more than 50% of the time. It seems that the more experienced dental hygienists have learned the importance of proper posture through experience. The lack of proper posture from respondents who have been practicing for less than 5 years indicates a need to have more or improved ergonomic instruction and evaluation during dental hygiene educational programs.

The number of respondents reporting pain in the neck and shoulders is not surprising since repetitive scaling has been linked to upper body pain.[4,9,12-16] This link is supported by the results of another study that showed a correlation between MSD pain in dental hygiene students and performing tasks such as hand scaling and ultrasonic scaling.[20] This correlation indicates the importance of finding ways to change patterns of clinical practice in order to reduce the amount of repetitive motion that is leading to MSD pain. Dental hygienists working in orthodontic practices have been reported to have less MSD pain than those working in a general dental or periodontal offices, a result that the authors suggested was due to dental hygienists in orthodontic practices generally performing a wider range of duties and less repetitive scaling tasks throughout the day.[12] Their data would suggest that repetitive scaling accounts for most of MSD in dental hygienists.

The use of loupes has the potential to minimize MSD pain. Previous studies of dental hygiene students have demonstrated that wearing magnification lenses or loupes improved head and neck positions and decreased neck, shoulder and back pain.[21,22] However, in this study the percentages of respondents wearing loupes for less than or for more than 4 hours did not differ between the no/mild pain and moderate/severe pain groups. The differing results may be due to the fact that the study population was not students, but practicing dental hygienists with a higher workload, less supervision on posture and less breaks while treating the patient. On the other hand, it has also been reported that licensed dental hygienists, using loupes as an adjunct to proper posture, maintained the health of their musculoskeletal system.[22]

Simply wearing loupes for a specified number of hours may not have been the critical issue to distinguish no/mild pain from moderate/severe pain. When these data are related to percentage of time using proper posture, 66% of the moderate/severe pain group uses loupes, but only 48% reported that they used proper posture. Thus, some respondents are not using proper posture while wearing loupes, and more experienced ones may have acquired proper posture habits without the benefit of loupes. Wearing loupes does not guarantee proper posture. Research projects need to be conducted to compare the types of loupes on the market in terms of factors, such as operator positioning. To study the interrelationship of loupes, proper posture and pain, one would need to photograph loupe-wearing participant to observe and record whether loupe-wearing does maintain proper posture. Loupes were not the central theme of this study, therefore the subject was not further explored.

These results show that exercise may not be a factor relating to MSD pain. The literature regarding the effectiveness of exercise in reducing MSD pain is mixed. Some studies, such as the current study, have found that there are minimal benefits of exercise on MSD pain,[23,24] while other studies suggest exercising reduces the amount of MSD pain.[25,26] This study did not inquire whether exercises were specifically addressing MSD. Additional studies need to be conducted to determine what specific types of exercise, if any, are best able to reduce pain from MSD, as certain exercises may even worsen the muscle imbalances of dental hygienists. Exercise and personal fitness programs should also be evaluated to determine whether they help prevent and minimize MSD pain.

The low response rate limits the ability to generalize these results to all CDHA members or to clinical dental hygienists in general. The fact that the survey was only distributed to CDHA members, for whom CDHA had email addresses, also would have caused the results not to be generalizable to all CDHA members. Also, the initial distribution of the survey to the CDHA membership contained a faulty survey link, which may have deterred dental hygienists from responding to the correct link when it was sent a few hours later. The lack of responses may also be due to a potential lack of interest on the topic from dental hygienists without pain, which may have exaggerated the percentage of respondents with MSD pain. Additionally, it is possible that dental hygienists who have retired due to MSD pain may no longer be members of CDHA, therefore minimizing the percentage of respondents with moderate and severe pain. Another limitation is that the term "proper posture" was not defined for the respondents and was self-reported. This subjective assessment could be influenced by many factures including the use of loupes.

Conclusion

The findings in this study indicate that workload and ergonomics are related to MSD pain. Educational programs need to emphasize the importance of these factors in the development and reduction of MSD pain among dental hygienists. Extensive ergonomics instruction and evaluation during dental hygiene educational programs may be able to prevent the

development of MSD pain in newly educated dental hygienists. Development of continuing education classes that allow experienced hygienists to access new information and techniques may minimize ergonomic risk factors associated with MSD. Recommendations to take frequent breaks from the repetitive motion of scaling and decrease workload during the workday may minimize muscle fatigue and thus pain. MSD is a multi-factorial disorder that requires further investigation into the many possible solutions.

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RESEARCH

Performance of Dental Hygiene Students in Mass Fatality Training and Radiographic Imaging of Dental Remains

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Abstract

Purpose: Mass fatality incidents can overwhelm local, state and national resources quickly. Dental hygienists are widely distributed and have the potential to increase response teams' capacity. However, appropriate training is required. The literature is void of addressing this type of training for dental hygienists and scant in dentistry. Hence, the purpose of this study was to assess one facet of such training: Whether the use of multimedia is likely to enhance educational outcomes related to mass fatality training.

Methods: A randomized, double-blind, pre- and post-test design was used to evaluate the effectiveness of comparable educational modules for 2 groups: a control group (n=19) that received low media training and a treatment group (n=20) that received multimedia training. Participants were second-year, baccalaureate dental hygiene students. Study instruments included a multiple-choice examination, a clinical competency-based radiology lab scored via a standardized rubric, and an assessment of interest in mass fatality education as a specialty. ANOVA was used to analyze results.

Results: Participants' pre– and post–test scores and clinical competency-based radiology lab scores increased following both educational approaches. Interest in mass fatality training also increased significantly for all participants (p=0.45). There was no significant difference in pre- and post-test multiple choice scores (p=0.6455), interest (p=0.9133) or overall competency-based radiology lab scores (p=0.997) between groups.

Conclusion: Various educational technique may be effective for mass fatality training. However, mass fatality training that incorporates multimedia is an appropriate avenue for training instruction. Continued research about multimedia's role in this specialty area is encouraged.

Keywords: radiology, mass fatality training, catastrophe preparedness, dental hygiene, education, multimedia

This study supports the NDHRA priority area, **Professional Education and Development:** Investigate curriculum models for training and certification of competency in specialty areas (e.g., anesthesiology, developmentally disabled, forensics, geriatrics, hospital dental hygiene, oncology, pediatrics, periodontology, and public health).

INTRODUCTION

Mass fatality incidents, whether natural or man-made, occur often and can overwhelm local, state and government agencies, resources, and personnel quickly.[1] Of critical importance is a rapid and effective response from skilled, multidisciplinary teams who are trained to manage each incident's aftermath, including the identification of the deceased.[2] Dental hygienists are widely distributed, and when trained in this area, can add to response capabilities during mass fatality incidents in all aspects of postmortem dental examinations.[2] Hence, preparation and training in anticipation of mass fatality incidents is vital.[2] The literature is void of models for mass fatality preparedness and victim identification in dental hygiene curriculum; however, mass fatality training has been recommended for predoctoral dental school curriculum.[3-6] Mass fatality training that incorporates computer-based multimedia to present topics through integrated text, sound, graphics, animation, video, imaging and spatial modeling has been used in developing forensic training in dental curricula.[3,7] Some dental educators believe exposure to and participation in forensic specialty coursework might also stimulate students' interest in serving their community as a disaster responder.[5,8]

Dental hygiene education provides competencies in administrative skills, dental radiology, dental examinations and documentation of the oral cavity applicable to a clinical setting. However, currently, there are no accreditation standards for mass fatality training in dental or dental hygiene curriculum.[3-6] Disaster victim identification during a mass fatality incident is the most important dental forensic specialty area for dental hygienists to participate

in, and they are recommended as viable respond-ers for disaster victim identification efforts.[9-11] The defined role of dental hygienists as a mass fatality team member includes serving as dental registrars for managing antemortem and postmortem dental records, providing surgical assistance for jaw resec-tions, imaging postmortem dental radiographs, and preforming clinical examinations of the oral cavity as part of the postmortem or records-comparison teams.[9-16] Identifying the deceased must be safe for emergency responders, as well as reliable and accurate.[2,17,18] However, dental hygiene participa-tion and education in mass disasters has been in-adequately addressed in the literature. Expansive training is needed and recommended because prac-titioners with special forensics training and experi-ence are better able to accomplish duties needed for identifications.[2,4-9]

There are a limited number of studies address-ing how disaster preparedness should be developed in dental curriculum. In dental education, More et al specifically recommends a multimedia approach for catastrophe preparedness with "hands-on" sim-ulations to provide an active learning experience, including mock disaster scenarios.[3] More et al's publication on the development of a curriculum to prepare dental students response to catastrophic events cites technology as "ideal" in combination with case studies, drills and dramatizations using multimedia and simulated events.[3]

Investigators have suggested that mass fatality training be interactive and provide assessments of skill acquisition, since regular practice and learn-ing keeps skills and best practices for emergency preparedness and response current.[5] Stoeckel et al[5] and Hermsen et al[6] recommend that forensic dental education for predoctoral dental school curriculums include identifying victims of a mass disaster, using portable radiology equipment and victim identifica-tion software systems. Repeated practice is required to strengthen skills in radiographic imaging tech-nique for exposure of postmortem dental remains.[19]

Meckfessel et al demonstrated that multimedia was effective in a dental radiology course.[19] The Department of Oral and Maxillofacial Surgery of the Hannover Medical School introduced an online, multimedia dental radiology course called "Medi-cal Schoolbook," for predoctoral third-year dental students.[19] It was designed to support multimedia learning modules.[10] In the low media module group, only 15 out of 42 students failed the radiology final examination. Two years after initiating the multime-dia, only 1 out of 67 students failed the radiology final examination.[19] The authors concluded that the radiology program benefited from additional media for teaching difficult concepts and transfer of knowl-edge.

Multimedia presentations of simulated events can provide an environment with authentic learning sit-uations that facilitate knowledge transfer and reten-tion beneficial for safe practice.[20] Mayer found that media supports the way the human brain learns.[22] His theory on the cognitive theory of multimedia learning supports dental educator's recommenda-tions for use of multimedia.[21] Mayer's theory centers on the idea that learners attempt to build mean-ingful connections between words and pictures, learning more deeply than with words or pictures alone.[20,21] In the absence of an actual mass fatality incident, learners need training resources that con-nect their established competencies with the addi-tional competencies or skills needed for mass fatal-ity training and forensics. Multimedia could provide easily deployable training modules, which could be reviewed repetitively with actual demonstrations for just-in-time training, including abbreviated training session for untrained volunteers during the time of an actual incident.

The key elements of Mayer's theory are based on 3 assumptions.[20] First, the dual-channel assump-tion is that working memory has auditory and visu-al channels. Mayer's "Modality Principle" states that people learn better from words and pictures when words are spoken rather than printed.[20,21] Next, the limited capacity assumption is that working mem-ory is limited in the amount of knowledge it can process at one time, so that only a few images can be held in the visual channel and only a few sounds can be held in the audio channel.[20,21] Lastly, the ac-tive processing assumption explains that it is nec-essary to engage our cognitive processes actively to construct a coherent mental representation and to retain what we have seen and heard. Leaners need to be actively engaged to attain or remember, organize and integrate the new information with other or prior knowledge.[20,21] Use of multimedia has several advantages including observation of simu-lated experiences and opportunities for visualizing a process or procedure before being involved physi-cally.[20-23] This provides potential for increased cog-nitive knowledge, analysis and application of new knowledge in a "safe" environment.[20-23] Stegeman and Zydney also found that learners who have re-peated access to information and videos had an ad-vantage over students who did not have access to the materials for further study.[23]

Mayer identifies improvement in learning as the "multimedia effect."[20] The presentation of audio and video are held in working memory simultaneously to create referential links between the two. In anoth-er study, Mayer et al found that onscreen text and images can overload the learner's visual process-ing system, whereas narration is processed in the verbal information processing system, requiring the student to both read and simultaneously view the

Table I: Two Group, Double-Blind, Randomized, Pre– and Post–Test Research Design

Pre-Test Measures Baseline	Treatment	Skill Assessment	Post-Test Measures	Final Sample
Experimental Group				
Online 15 question pretest	Multimedia educational module intervention	Clinical Competency Based Radiology Lab on simulated dental remains	Online 15 question posttest	Total: 20
Control Group				
Online 15 question pretest	Low media educational module intervention	Clinical Competency Based Radiology Lab on simulated dental remains	Online 15 question posttest	Total: 19
				Total: n=39

image.[22] Both activities use a single channel, the visual channel. Video is single-channeled because our brains already pull the underlying video and audio together, and is considered multimedia.[20,21] Because multimedia uses a single-channel only, researchers believe information is easier to remember and retain.[20,21] An image with accompanying narration is using dual channels, whereas narration is processed in the verbal information processing system, part of the auditory channel.[20,21] Dual-channeling usually involves pictures and sounds, such as a narrated PowerPoint.

Emergency experts have underlined disaster preparedness as a way to reduce the many challenges that occur during incident response and management.[1-18] This study investigates the effectiveness of strategies for mass facility training among dental professionals. More specifically, it assesses whether the use of multimedia is likely to enhance educational outcomes related to mass fatality training. Multiple-choice examination scores and clinical competency-based radiology lab scores of 2 groups of second-year dental hygiene students were completed. Interest in this specialty area for each training approach was also accessed.

Methods and Materials

Mayer's "Modality Principles," as well as Stoeckel et al's recommendations for mass fatality training in dental students was the basis for the use of multimedia and a "hands on" clinical competency-based radiology lab for the mass fatality training in this study.[3-6,20] A 2-group, randomized, double-blind, pre- and post-test research design was used (Table I). The sample for this educational evaluation included dental hygiene students in their first semester of their second year of an entry-level baccalaureate degree program. All participants were required to have completed prerequisite coursework, to have completed 1 year in Oral Radiology, and to be certified

in Virginia radiation safety. Pregnancy or suspected pregnancies were part of the exclusion criteria, due to the use of portable radiation devices in atypical positions. After Institutional Review Board approval, the researchers invited students to participate in the study via on an online announcement. Participation was voluntary and students could withdraw from the study at any time without impacting their status in the dental hygiene program; 42 participants completed informed consent documents and were enrolled and randomly assigned to either the control group (n=21) or experimental group (n=21).

The control group viewed an educational module with low media (dual channeling), while the experimental group viewed information with multimedia (single channel). For the purpose of this study, multimedia was defined as media that integrated text, graphics, audio and video demonstrations to allow for self-pacing, repetition of reading text, listening to and viewing materials, and/or guided demonstrations. Low media was defined as using teaching presentation software with text and graphics (PowerPoint) that also allowed for self-pacing and repetition, but only through reading and in a one-dimensional visual context.

The content for both of the educational modules were comparable, and developed by an instructional designer and dental hygiene faculty who have emergency preparedness and response training. All student participants viewed their assigned educational module with unrestricted access before participating in the clinical competency-based radiology lab. Both educational modules were deployed online via the University supported Blackboard Learning system®.

The educational modules for both multimedia and low media were of parallel content and included the definition of forensic odontology, the role of the dental hygienist during a mass fatality incident, and victim identification. The educational module specifically

addressed biosafety considerations, personal protective equipment, and sterilization procedures in the mortuary setting. Dental radiography topics included techniques for using portable hand-held radiographic equipment when imaging simulated victim remains and safe exposure of postmortem radiographs. An online pretest was given before viewing the educational module. The post-test was administered after student participants viewed the educational module and completed the clinical competency-based radiology lab. The multiple choice pre- and post-test had the same 15 forced-choice questions on interest in mass fatality training and on taking radiographs on victim remains (2 questions), knowledge of forensics (2 questions), personal protective equipment (PPE), and infection control in a mortuary setting (4 questions), radiation safety (3 questions) and radiographic technique when imaging simulated victim remains (4 questions). Students had 1 week prior to their clinical competency-based radiology lab to view the educational module in full. The clinical competency-based radiology lab included exposure of 11 intraoral radiographs on 6 fragments of lubricated and real human skulls with bitewing, anterior and posterior periapical images.

To evaluate the performance of students on their technique when imaging dental remains, all radiographic images were scored by 2 calibrated examiners, and a radiographic evaluation form was used to identify errors in the following categories: angulation, placement, exposure and density. Errors were entered as: 0=no error, 1=slight error not indicating a retake of the image and 2=nondiagnostic error requiring retake of the image. Students received instructions on technique through the educational module. No instruction on radiographic technique was given during the radiology lab portion of the study, and there were no retake exposures. Lab equipment included a portable handheld x-ray device (Nomad Pro®; Aribex, Inc™, Charlotte, NC), a direct digital image sensor (Schick Elite®; Sirona Dental Inc.™, Long Island, NY), and a modified image receptor holder, which is used at onsite, temporary morgues during mass fatality incidents.

Quantitative data analysis of interactions, pre- and post-test results, and radiology laboratory results were performed using SAS® 9.3 software. Significant differences existed at α=0.05 for analysis of variance (ANOVA), after the assumption of normality and equality of variance had been met. Assumptions of equality of variances to validate the statistical tests performed were also conducted. More specifically, the Levene's test, Brown-Forsyth and Bartlett tests for homogeneity of variance were found to have high p-values, indicating that additional corrections were not necessary prior to making comparisons between groups.

RESULTS

A total of 39 participants out of 42 (92.8%) completed the pre- and post-test for the multiple choice exam (experimental group (n=20), and the control group (n=19)); 38 participants completed the radiology lab portion of the study (experimental group (n=20), control group (n=18). One and 2 participants were excluded from each experimental and control groups, respectively because they did not complete the research protocol in its entirety.

The means and standard deviations for the experimental and control groups were calculated. The mean sum pretest score for both groups combined was 8.1 (SD=1.32). The mean sum pre-test score within the experimental group was 8.4 (SD=1.35), and 8.2 (SD 1.32) in the control group. Post-test scores for the groups combined was 9.9 (SD=1.40), 9.95 (SD=1.23) within the experimental group, and 10.0 (SD=1.6) within the control group. ANOVA indicated no significant gain between the groups; however, there was significant improvement in scores within each group (Table II).

In the control group, the mean score for the pre-test was 8.2 (SD=1.31), with a mean post-test score of 10.0 (SD=1.59). Similar analysis revealed a significant improvement in scores with p-value <0.0001. Students reported similar interest in learning more about the role of the dental hygienist in disaster victim identification for mass fatality incidents from baseline (99.9%) to post-test (94.8%). Students reported slightly more interest in exposure to radiographic images on postmortem remains at the post-test (94.7%) compared to baseline (88.6%). Specifically, interest in disaster victim identification had significant gain from pretest to post-test scores, where the mean difference score was -0.07 (SD=0.634) (p=0.45). Results also suggest students from both groups showed an increased interested in postmortem radiographic imaging after the educational modules and clinical competency-based radiology lab, with a mean difference score of 0.12 (SD=0.57).

Overall, the participants performed well in both the educational modules and clinical competency-based radiology lab with some improvement from pre- and post-test scores within the groups and little difference in score between the 2 groups. In the experimental group, the mean score of 0.3 (SD=1.09) revealed no significant gain in radiation technique knowledge (p=0.16). Within the control group, there was also no significant difference in radiation technique knowledge, with a mean score of 0.26 (SD=0.81). For radiation safety, there was a statistically significant gain in knowledge from pre- to post-test sum between the groups with a mean score of 0.69 (SD=0.76) (p <0.0001). The experimental

Table II: Pre– and Post–Test Comparison Score

	Total participants n=39	Experiment Group n=20	Control Group n=19	p–value
Pretest (scores, mean ± SD)	8.31 ± 1.32	8.40 ± 1.35	8.21 ± 1.32	0.6604
Posttests (scores, mean ± SD)	9.97 ± 1.40	9.95 ± 1.23	10.00 ± 1.60	0.9133
Diff post pre-test (scores)	1.67 ± 1.59 (<0.0001a)	1.55 ± 1.88 (0.0015b)	1.79 ± 1.27 (<0.0001c)	0.6455
Disaster Victim Identification Interest	-0.07 ± 0.62 (0.4457)	0.01±0.55 (0.4283)	-0.05±0.40 (0.5778)	0.3335
Radiographic Imaging for Disaster Victim Identification Interest	0.10 ± 0.50 (0.2100)	0.15 ± 0.58 (0.2674)	0.05±0.40 (0.5778)	0.5522
Radiation for technique Differences	0.31 ± 0.95 (0.0502)	0.35 ± 1.09 (0.1670)	0.26 ± 0.81 (0.1716)	0.7797
Radiation for safety Differences	0.69 ± 0.73 (<0.0001a)	0.55 ± 0.69 (0.0020b)	0.84 ± 0.76 (0.0001c)	0.2167
Forensic Knowledge Difference	-0.10 ± 0.50 (0.2100)	-0.10 ± 0.45 (0.3299)	-0.11 ± 0.57 (0.4291)	0.9744
Knowledge of Infection Control Differences	0.77 ± 0.71 (<0.0001a)	0.75 ± 0.79 (0.0004b)	0.79 ± 0.63 (<0.0001c)	0.8641

$p < 0.05$ as statistical significant
a Significant gain within the total number of participants
b Significant gain within the experiment group
c Significant gain within the control group

Table III: Clinical Competency Based Radiology Lab Errors (n=38)

	Experiment Group n=20	Control Group n=18	p–value
Overall	21.95 ± 4.52	21.94 ± 5.42	0.997
Error Category:			
Placement	6.80 ± 2.98	7.22 ± 2.71	0.652
Angulation	0.55 ± 0.69	0.84 ± 0.76	0.902
Exposure	0.20 ± 0.62	0.11 ± 0.32	0.587
Other	0.35 ± 0.75	0.17 ± 0.51	0.389

$p < 0.05$ as statistical significant

group mean scores were 0.55 (SD=0.68) and the control group mean scores were 0.84 (SD=0.76). There was no significant gain in scores between the 2 groups for forensic knowledge (p=0.210). Mean scores for the experimental group were -0.10 (SD=0.45) and the control group means score was -0.1 (SD=0.57). Lastly, a statistically significant difference was found between the 2 groups in terms of infection control scores (p <0.0001). The experimental group had a mean score of 0.75 (SD=0.79), and the control group was 0.79 (SD=0.63). The correlation between radiation safety and technique was of 0.33 (p= 0.0406). Therefore, a strong relation existed between the 2 variables. The greater the radiation safety scores, the greater the radiation technique score in both groups.

For the clinical competency-based radiology lab portion of the study, the higher the score on the radiographic evaluation form, the worse the performance or increase in errors per radiographic image. The experimental group had an overall mean score of 21.95, and the control group had an overall mean score of 21.94. No significant difference was found between the experimental and control groups in overall laboratory scores (p=0.997). Comparisons were also made between the experimental and control groups in the specific error categories, which included errors in placement of the digital image receptor, vertical and horizontal angulation errors of the position indication device, exposure errors, mounting errors and an "other" category for errors that did not fall within one of the above mentioned

categories. Between the 2 groups, there were no significant differences within the 4 categories of radiographic technique errors. Table III presents the means, standard deviations and related p-values for each category. Since there were no mounting errors recorded for either group, this category was omitted.

Discussion

This study compared a low media and multimedia approach to mass fatality training via a multiple-choice examination, competency-based radiology lab and an assessment of changes in interest in mass fatality as a specialty. This type of research is not currently found in dental hygiene literature. The mass fatality training review suggested that approaches to preparing dental hygienists for disaster response and victim identification needs to be further explored. This study addressed this gap in the literature by looking specifically at dental hygiene mass fatality training within the framework of what has been published in the dental curriculum.

The majority of participants in each group at the post-test reported a high level of interest in mass fatality training and in disaster victim identification through exposing radiographic images on simulated victim remains, which supports Stoeckel's idea that exposure to specialty coursework can encourage interest.[5] Exposure to training in the forensic specialty area also gives dental and dental hygiene students the opportunity to decide whether they are interested in pursuing further training.

No statistically significant differences existed between the 2 groups; however, scores increased within each group. Both approaches resulted in increased scores. This increase in scores supports the recommendation by More et al for the use of multimedia for mass fatality training.[3] The discrepancy between the groups may be explained by what Jonassen describes as focusing on the student rather than a focus on the media.[24] Jonassen states that "any reasonable interpretation of an instructional medium should be more than a mere vehicle."[24] He explains that educators should not assume that by simply adding media, the student's cognitive processes will integrate the new information with the old.[24] Students may not have been fully engaged with the media during the lesson. Also, while multimedia modules are designed to facilitate a way for students to repeat, interrupt and resume the lesson at will, there is a large assumption that they will take advantage of those benefits. Students may choose to "cram" with technology and multimedia based modules. Another explanation could be due to the small sample size (n=21 in each group) which may have limited statistical power. In general, the results of our evaluation revealed that pro-

viding mass fatality training can be offered through a multimedia approach.

For the clinical competency-based radiology lab assessment, both groups had a similar mean score from baseline to post-test with a 0.01 difference. In radiology education, a multimedia module with visual, audio demonstrations and supplemental face-to-face instructor guided lab demonstrations for skill acquisition may produce improved lab scores in the future. The educational modules allowed students to view demonstrations as needed, prior to the lab for review of difficult radiology concepts. This study supports that for difficult, hands-on skills such as radiographic technique, media could be used to enhance the learning process. These results support Stoeckel et al and Hermsen et al's recommendation for simulated exercises that allow students to practice clinical competencies such as the use of the portable radiology equipment and postmortem radiographic imaging.[5,6]

This study has some general limitations that preclude generalizing results to practice. Threats to the validity of the pre– and post–test include the small sample size and the use of a convenience sample of dental hygiene students from an entry-level BS program. Since students were in the same program, it is possible that participants in the experimental group could have shown participants in the control group the multimedia educational module; participants could have also shared their clinical competency-based radiology lab experience with participants who had not taken that portion of the research study. The amount of study time is unknown since both educational modules were delivered online. Future studies should include larger samples sizes with a diverse sample of dental and dental hygiene students, practicing dentists and dental hygienists, and other dental team members from various universities and colleges. Additionally, this study did not utilize a full curriculum approach because participants were evaluated based on one educational module and one attempt at the clinical competency-based radiology lab; researchers did not test long term knowledge retention. Glotzer et al[4] and More[3] recommend catastrophe preparedness curriculum that is offered through multiple semesters by "supplementing the established curriculum with units of instruction." Future research should identify educational methodologies that improve learning. The pre- and post-test limitations include asking 15 multiple choice questions; a more reliable instrument would include questions covering a wider span of information. Modifications in research design and implementation may be required for application of instruction in different environments to include dental curriculum or just-in-time training during an actual mass fatality incident. Additionally, researchers were not able to test whether multi-

media might have an impact on the participant's level of function during a mass fatality incident; it is unknown whether or not a multimedia training approach would lead to better outcomes and recall in higher stress situations.

This study contributes to the dental hygiene literature by assessing the effectiveness of multimedia in incorporating mass fatality training and radiographic imaging of dental remains specific to dental hygiene. Multimedia approaches have been identified in the dental publications and curriculum; however, there are no peer-reviewed publications on what type of educational methodology should be used for mass fatality training for dental hygienists.[5,19] These findings, although based on a small sample size, demonstrated minimal differences when using a multimedia versus low media approach to mass fatality training. A combined approach could be used to develop training modules specific to dental hygiene mass fatality preparedness, response training and simulated lab exercises allowing students to practice clinical competencies that are beneficial for taking radiographs on simulated victim remains. Future research should include more diverse, multidisciplinary samples and longitudinal data.

Conclusion

Dental hygienists have participated in mass fatality and show promise in acts of community ser-

vice and volunteerism. Training in anticipation of a mass fatality incident is important for increasing the number of skilled and deployable dental professionals for recovery efforts.[10]

As training applicable to dental hygiene is developed and tested, dental hygienists can continue to add to response capabilities during a mass fatality incident. Additional research in this area could contribute to identification of teaching methods to to better prepare dental hygienists for a mass fatality incident.

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RESEARCH

Assessing Evidence-Based Practice Knowledge, Attitudes, Access and Confidence Among Dental Hygiene Educators

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Abstract

Purpose: To assess U.S. dental hygiene educators' evidence-based practice (EBP) knowledge, attitude, access and confidence and determine whether a correlation exists between assessment scores and level of education, length teaching and teaching setting (didactic, clinical or both).

Methods: A cross-sectional survey was conducted with a sample of dental hygiene faculty from all 334 U.S. dental hygiene schools. ANOVA and Pearson correlation coefficient statistical analysis were utilized to investigate relationships between demographic variables and application of evidence-based principles of patient care.

Results: This study involved a non-probability sample (n=124), since the total faculty among all U.S. dental hygiene schools was not determined. Analysis demonstrated a positive correlation between EBP knowledge, access and confidence scores indicating that as knowledge scores increased, so did confidence and access scores (r=0.313, p<0.01 and r=0.189, p<0.05, respectively). Study findings also revealed that faculty who held advanced educational degrees scored significantly higher in EBP knowledge (F3,120=2.81, p<0.04) and confidence (F3,120=7.26, p<0.00).

Conclusion: This study suggests the level of EBP knowledge, attitude, access and confidence increases with additional education. Therefore, more EBP training may be necessary for faculty who do not possess advanced education. Results of the study indicate that further incorporation of EBP into dental hygiene curricula may occur as dental hygiene educators' knowledge of EBP increases, which in turn could enhance students' acquisition of EBP skills and their application of EBP principles toward patient care.

Keywords: evidence-based practice, evidence-based dentistry, dental hygiene, dental education

This study supports the NDHRA priority area, **Professional Education and Development:** Investigate the extent to which new research findings are incorporated into the dental hygiene curriculum.

INTRODUCTION

Evidence-based practice (EBP) has become a widely accepted systematic approach utilized by health professions including medicine, nursing, dental and dental hygiene.[1,2] The evidence-based movement was initiated to improve patient care by closing the gap between what is known and what is practiced.[3,4] An exponential growth in research literature provides a challenge for health care providers to stay abreast of the latest available evidence; however, the acquisition of knowledge alone is not sufficient to provide quality patient care.[5-7] Therefore, the evidence-based decision making (EBDM) process has evolved into a formalized and systematic process that not only includes finding and interpreting the best scientific evidence available, but also takes into consideration the patient's personal preferences/values, patient/clinical circumstances, and the clinician's experience and judgment.[6,7]

The American Dental Hygienists' Association (ADHA) Standards of Care state that it is a dental hygienist's professional responsibility to be able

to access and utilize current, valid and reliable evidence in clinical decision making by appropriately analyzing and interpreting the literature and other resources.[7] Additionally, the new revisions of the Commission on Dental Accreditation (CODA) standards provide additional support for EBP by expanding the suggested competency criteria a dental hygiene graduate should be able to demonstrate regarding problem solving strategies related to comprehensive patient care and management of patients.[8]

A crucial component in the acquisition of knowledge and skills necessary for EBP is formal education in that specific area of expertise.[9-16] An assessment of health professions' education, including dental education, has identified the need for teaching EBP principles in program curricula in order to assist students in acquiring the necessary skills to provide quality patient care that is based upon valid and reliable evidence.[4,17-25] According to the literature, 2 major outcomes must be achieved to expe-

dite the translation of research into clinical practice: dental hygiene educators must develop and possess sufficient EBP knowledge and skills and be able to teach their students the EBP process.[7,26] Previously, dental hygiene program directors have reported they felt their faculty were lacking in EBP knowledge and skills.[11] Therefore, in order for EBDM to become the norm in clinical EBP, program curricula reform is necessary for practitioners to gain the skills necessary to apply EBDM principles that will close the gap between what is known and what is practiced.[13]

Literature suggests that dental hygiene faculty attitudes and knowledge can have an impact on the integration of EBP principles into program curricula.[5,17,23] Although limited, there is literature that suggests dental hygiene educators feel better prepared to teach and incorporate EBP philosophies into curricula once they have received sufficient training.[5] This in turn can affect the degree and ability of dental hygiene educators to teach EBP, which can impact EBP student learning outcomes. Currently, there is limited research assessing the impact education has on the utilization of EBP principles, however research supports that increasing the teaching of EBP principles has the potential to positively impact the students' perception of their ability to practice evidence-based oral health care.[12,14,27,28] Studies have shown that knowledge, attitude and confidence regarding EBP can have a direct impact on the extent a clinician practices evidence-based patient care.[29-31] Factors such as level of education, attitude toward EBP and perceived confidence in one's ability to use evidence-based principles have been shown to have an impact on the capability and degree of accessing scientific literature.[29,31-34] Although studies indicate that oral-health and other health care providers have a positive attitude toward EBP, there continues to be a lag in progress of all health care professions incorporating evidence-based principles into clinical care. The information from these studies suggests more support is needed for adding EBP education into health care curriculum.[35-37]

Studies have been conducted that have attempted to assess the knowledge, attitudes and utilization of EBP principles and the impact education has in acquiring those skills.[38-43] Systematic reviews of several studies have shown that the evaluation designs of much of this research were faulty and valid survey instruments were not utilized, which impacted interpretation of the study results.[44,45] Validated assessment instruments have been developed to assess EBP in the medical profession, which utilized questionnaires to evaluate perceived acquisition of EBP knowledge, attitudes toward EBP, search strategies, frequency of use of evidence sources, current application of EBP, intended future use of EBP and confidence in applying EBP principles.[46-49] These assessment instruments were developed for

the medical profession and the questions, terminology and patient care scenarios were medically focused.[25] Therefore, in order to fill a void in the evaluation of EBP in 2011, an assessment instrument the Knowledge, Attitudes, Access, Confidence Evaluation (KACE) was developed and validated to assess EBP knowledge, attitudes, access and confidence specifically in dental education.[25] The KACE survey instrument was assessed and validated for consistency among the KACE scales, the ability to differentiate between individuals with varying levels of education or experience, and the capacity to detect the effects of education. Strengths of the KACE include its consistency within scales which reported Cronbach alpha coefficients from 0.21 to 0.78 for knowledge, 0.57 to 0.83 for attitude, 0.70 to 0.84 for accessing evidence, and 0.87 to 0.94 for confidence. Overall, the KACE was determined to hold a similar construct reliability to EBP assessment instruments utilized in medicine.

Current literature has explored the importance of EBP in improving patient care, the impact of education and assessed research utilization by health care and dental providers, but limited research has been conducted assessing dental hygiene educators' knowledge, attitude, ability to access research literature and confidence utilizing EBP principles. Therefore, the purpose of this research study was to assess U.S. dental hygiene educators' level of knowledge, access to evidence, attitude and confidence in using EBP principles by using the KACE assessment instrument. This study also sought to determine whether there is a correlation between the educator's level of education, years of teaching or teaching setting (didactic, clinical or both) and the participants' knowledge, attitudes, skills and confidence in utilizing EBP principles.

METHODS AND MATERIALS

A cross-sectional survey was conducted with a convenience sample of dental hygiene faculty from 334 U.S. dental hygiene schools. This included 246 associate granting dental hygiene programs and 88 baccalaureate dental hygiene programs. Program director information was obtained from the ADHA web page (www.adha.org). A cover letter along with a link to the online survey was electronically mailed in September, 2013 to all 334 U.S. dental hygiene program directors. The program directors were asked to pass along the survey to all of their full and part-time faculty members. The electronically mailed cover letter informed the participants of the benefits and risks of participating and that their responses would be anonymous. Participants were also informed that all participation was voluntary and no incentives were given. A reminder cover letter with the link to the survey was sent to the same U.S. dental hygiene program directors after 2 weeks. Prior to conducting

the study, approval to collect and analyze the data was obtained by the UMKC Social Sciences Institutional Review Board (UMKC IRB Protocol 13-737).

Data were collected utilizing the KACE assessment instrument developed and validated by Hendricson et al of which the methods have been previously published.[23] The KACE assessment instrument includes a total of 35 questions: EBP knowledge (10), EBP attitudes (10), EBP access to evidence (9) and EBP confidence (6). The wording in the KACE instrument was modified to address dental hygiene educators rather than dental students. The knowledge questions are multiple choice in a 1-best-response format and the participants were given the option "I don't know" in order to minimize random guessing. All of the knowledge responses were recorded as either incorrect or correct and the correct responses were given a score of 1 and the incorrect/I don't know responses a score of 0. The survey questions assessing EBP attitudes, access and confidence utilize a 5-point Likert scale. The attitude questions include a scale ranging from 1 (strongly disagree) to 5 (strongly agree). The access of evidence questions include a scale ranging from 1 (never use) to 5 (very frequently use). For confidence, the scale ranges from 1 (not at all confident) to 5 (very confident).[23] Since the KACE assessment instrument was previously validated, a pilot study was determined not necessary.

In addition to completing the KACE assessment, participants were asked demographic items such as respondent's level of education, number of years teaching, degree awarded by institution (masters, bachelors, associate or certificate), work status (full time or part time) and teaching appointment (didactic, clinical or both). Exploratory analysis including descriptive statistics, percentages and frequencies was completed. ANOVA with post hoc pairwise comparison utilizing the Tukey-Kramer test and Pearson correlation coefficient statistical analysis were conducted to investigate whether significant differences or a correlation existed between demographic variables and the level of knowledge, attitudes, access to evidence and confidence in applying evidence-based principles toward patient care.

RESULTS

There were 124 dental hygiene faculty who responded to the survey. Since the survey did not ask if the respondent was the program director or a faculty member, the number of responses represent a non-probability sample. Although the total number of faculty in U.S. dental hygiene programs was not determined, some very valuable and rich information was gathered from the survey responses. Figure 1 depicts the educational level of the respondents. Respondents' length of teaching and teaching appointment are reported in Tables I and

Figure 1: Participant's Educational Level

PhD	
Associate	
Baccalaureate	
Masters	
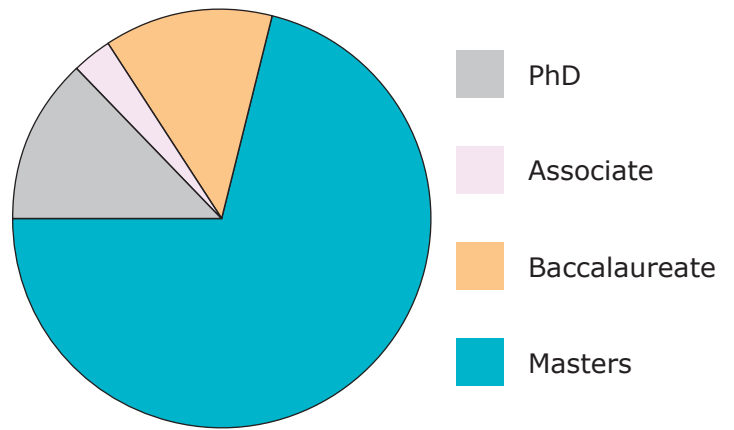
Table I: Participants' Length Teaching in Dental Hygiene Curricula

0 to 5 years	20% (n=25)
6 to 10 years	19% (n=24)
11 to 15 years	23% (n=28)
16 or more years	38% (n=47)

Table II: Participants' Teaching Appointment

Didactic	9% (n=11)
Clinical	15% (n=19)
Both Didactic and Clinical	69% (n=86)
Other	7% (n=8)

II, respectively. Over half of the respondent's held an associate's degree (65%) followed by a baccalaureate degree (44%), master's degree (27%) and a certificate (11%).

KACE Assessment

There were a total of 10 knowledge questions regarding evidence-based practice (Table III). Overall, the respondents were able to identify the components of a Patient, Intervention, Comparison, Outcome (PICO) question, determine the appropriate search strategy when using an electronic database, identify the type of research study utilized and appropriately analyze the results of a research study. Of the 2 questions related to rating the level of evidence, the majority (60.5%) responded correctly to one, but (58.9%) did not respond correctly to the other. Also, the majority (74.2%) of respondents were not able to correctly determine the appropriate study design for the type of research being conducted. Over half of the respondents were not able to correctly differentiate between sensitivity and specificity and all (100%) either did not know or incorrectly differentiated between incidence and prevalence.

Table III: Responses to Knowledge Questions

Type of Question	Correct	Incorrect/I don't know
Determining Level of Evidence	41.1% (n=51)	58.9% (n=73)
Determining Level of Evidence	60.5% (n=75)	39.5% (n=49)
Literature Search Strategy	61.3% (n=76)	38.7% (n=48)
Analyzing Study Results	75% (n=93)	25% (n=31)
Identifying PICO Components	69.4% (n=86)	30.6% (n=38)
Analyzing Study Results	60.5% (n=75)	39.5% (n=49)
Identifying Research Study Design	79% (n=98)	21% (n=26)
Determine Appropriate Study Design Needed	25.8% (n=32)	74.2% (n=92)
Differentiating Between Sensitivity and Specificity	48.4% (n=60)	51.6% (n=64)
Differentiating Between Prevalence and Incidence	0% (n=0)	100% (n=124)

Overall, the participants reported a positive attitude toward EBP and reported a variety of sources for accessing dental evidence. The majority of respondents reported they were moderately confident or confident in their critical appraisal skills of EBP. All responses to the attitude, access to evidence and confidence questions are reported in Table IV.

Analysis of KACE Responses with Demographic Variables

There was a moderate correlation between confidence score and knowledge scores. Participant confidence in using EBP increased as their EBP knowledge increased. Also, increased confidence was associated with a positive attitude toward EBP and as confidence using EBP principles increased so did the participants' access of evidence-based literature. A weaker correlation existed between access and knowledge scores. A correlation also existed between evidence-based access and attitude scores showing that a more positive attitude resulted in an increase in access of scientific literature. There was highly significant positive correlation between degree level attained and confidence scores, indicating that confidence increased with a higher level of education. There was also significant relationship between the highest degree offered and knowledge and confidence scores. Pearson correlation results are reported in Table V.

Statistical analysis of knowledge scores by ANOVA revealed an overall significant difference between knowledge and highest degree offered by the institution groups. Post hoc pairwise comparison using the Tukey-Kramer test among groups indicated that faculty teaching at educational institutions where a master's degree is the highest degree offered scored significantly higher on the knowledge and confidence scales than those teaching at institutions where an associate degree is the highest degree offered. A significant difference was shown between confidence scores and degree level obtained and post hoc comparisons indicated that confidence levels increased with the level of education. No statistical differences were seen between KACE scores and the type of institution where the faculty teach. For example, there were no differences between community colleges and university settings. Some statistical difference was seen only between length of time teaching and access to evidence scores. Post hoc comparison indicated that those teaching for 16 or more years accessed dental evidence slightly more than those teaching for 11 to 15 years. ANOVA showed a statistical difference between teaching appointment (didactic, clinical or both) and knowledge, evidence-based access and confidence scores. Post hoc comparisons indicated that those who teach didactic courses scored significantly higher for knowledge scales than those who teach only in a clinical setting. Post hoc comparisons showed that those that teach both didactic and clinic accessed dental evidence more than those that teach clinic only. Post hoc comparison also indicated that those that teach didactic or both didactic and clinic courses have more confidence utilizing EBP than those that teach in a clinical setting only. Post hoc comparison also revealed a statistical difference between work status (full/part time) and attitude and confidence scores showing those that teach full time have increased confidence and attitude toward EBP (Table VI).

DISCUSSION

The purpose of this study was to assess current U.S. dental hygiene educators' knowledge, attitude toward, ability to access evidence and confidence utilizing EBP principles and to determine whether there is a relationship between variables such as degree level obtained, type of institution taught, years teaching, or teaching appointment. The majority of respondents understand the components of a PICO question, have knowledge of the various

Table IV: Attitudes, Access, and Confidence about Evidence-Based Practice (EBP) in Dentistry

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
Attitudes Toward EBP					
I believe that evidence-based practice is valuable in the practice as a dental hygienist.	1.6% (n=2)	0.8% (n=1)	0% (n=0)	23.4% (n=29)	74.2% (n=92)
I personally appreciate the advantages of practicing evidence-based patient care.	1.6% (n=2)	0.8% (n=1)	0.8% (n=1)	29% (n=36)	67.7% (n=84)
EBP should be an integral part of dental hygiene school curriculum.	1.6% (n=2)	0% (n=0)	2.4% (n=3)	22.6% (n=28)	73.4% (n=91)
Accessing Evidence					
How frequently do you access dental evidence from …	Never	Rarely	Occasionally	Often	Very Frequently
Colleagues: other dental hygienists, dentists or health care providers	1.6% (n=2)	5.7% (n=7)	0% (n=0)	39.5% (n=49)	53.2% (n=66)
Textbooks	0.8% (n=1)	8.1% (n=10)	23.4% (n=29)	41.9% (n=52)	25.8% (n=32)
The Internet (excluding Cochrane reviews)	0% (n=0)	6.5% (n=8)	32.3% (n=40)	42.7% (n=53)	18.6% (n=23)
Original research papers published in peer-reviewed journals	0.8% (n=1)	4% (n=5)	16.1% (n=20)	47.6% (n=59)	31.5% (n=39)
Confidence in Critical Appraisal Skills					
How confident are you at appraising the following aspects of a published research report?	Not at All Confident	Not Confident	Moderately Confident	Confident	Very Confident
Appropriateness of the study design	2.4% (n=3)	4.8% (n=6)	48.4% (n=60)	30.7% (n=38)	13.7% (n=17)
Generalizability of the findings	1.6% (n=2)	8.9% (n=11)	35.5% (n=44)	42.7% (n=53)	11.3% (n=14)
Overall value of the research report	0.8% (n=1)	4.8% (n=6)	37.1% (n=46)	47.6% (n=59)	9.7% (n=12)

If you feel that you cannot respond because of lack of information, lack of experience or uncertainty, please check the column labeled "uncertain."

levels of evidence and are able to analyze the results of a research study. Dental hygiene educators' appear to possess more EBP knowledge as compared to dental practitioners.[43] Study participants had difficulty differentiating between the following statistical terms: sensitivity, specificity, prevalence and occurrence. The positive relationship between degree level obtained and EBP knowledge shown in this study supports the role education has in the attainment of evidence-based knowledge.[9-16] Faculty that teach didactic or both didactic and clinic scored higher in EBP knowledge than those that taught

only in the clinic, which may indicate that additional education may be necessary for adjunct faculty who only teach in clinical settings. Therefore, education appears to play an important role in the attainment of EBP knowledge giving additional support to previous research studies.[9-16]

The respondents overall attitude was positive regarding the benefits of EBP toward patient care and the study results indicated that positive attitudes toward EBP increases the degree to which faculty access evidence-based literature, therefore, reinforc-

Table V: Pearson Correlation: Knowledge, Attitude, Access and Confidence Scores

	Knowledge Score (n=124)	Attitude Score (n=124)	Access Score (n=124)	Confidence Score (n=124)
Knowledge	–	–	0.189*	0.313**
Attitude	–	–	0.242**	0.291**
Access	0.189*	0.242**	–	0.423**
Confidence	0.313**	0.291**	0.423**	–
Degree Level Attained	–	–	–	0.38**
Highest Degree Offered	0.26**	–	–	0.24**

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Table VI: Data Concerning KACE Assessment Scores With Significant Difference and Demographic Variables

KACE Assessment Scores and Demographic Variable	ANOVA
Knowledge and highest degree offered	F(2,121)=4.34, p<0.02
Confidence and degree level obtained	F(3,120)=7.26, p<0.001
Access and length of time teaching	F(3,120)=2.70, p<0.05
Knowledge and teaching appointment (didactic, clinical or both)	F(3,120)=2.79, p<0.04
Access and teaching appointment (didactic, clinical or both)	F(3,120)=3.00, p<0.03
Confidence and teaching appointment (didactic, clinical or both)	F(3,120)=3.82, p<0.01
Post hoc Tukey-Kramer test results	
Knowledge and degree offered (master's vs associate degree)	p<0.01
Confidence and degree offered (master's vs associate degree)	p<0.01
Knowledge and teaching appointment (didactic vs clinic only)	p<0.04
Access and teaching appointment (didactic and clinic vs clinic only)	p<0.05
Confidence and teaching appointment (didactic vs clinic only)	p<0.01
Confidence and teaching appointment (didactic and clinic vs clinic only)	p<0.05
Attitude and work status (full/part time)	p<0.001
Confidence and work status (full/part time)	p<0.02

ing previous research.[29-31] For example, Melnyk et al also found a positive correlation (r=0.32, p<0.001) between EBP beliefs and the extent to which the nurses practiced evidence-based care.[31] It is interesting, that although the foundation of EBP relies on routinely accessing evidence and integrating the most current and relevant research, the majority of educators reported that they rely on colleagues and textbooks most frequently for information. While experts in the field may have a wealth of scientific knowledge, clinical experience, credibility, and be a quick and easy source of information, their opinions can be subject to bias and conflict of interest.[50] Also, the use of textbooks as a source of evidence is problematic since the information may be more than a decade out of date at the time of publishing.[51] Ideally, clinicians as well as educators should be utilizing electronic databases to locate scientific literature for additional evidence to support their teaching and practice.[50] Although faculty in this study frequently reported looking to online sources for current evidence-based literature, the majority continue to look to colleagues and textbooks as common sources of information. The use of podcasts or databases of critically appraised topics were not reported to be frequent sources of information, which may be due to these sources being newer forms of resources to dental hygiene educators. Interestingly, the overall participants' responses relative to confidence were either moderately confident to confident rather than very confident suggesting that educators feel they may need more EBP education. Previous research has shown lack of time as a barrier to EBP, but the majority of respondents in this study reported that EBP was a routine part of their teaching and felt that it was feasible to apply its principles toward patient care.[31,37] There appears to be an increase in EBP utilization, which may be

associated with participants' knowledge and attitude of EBP. The positive correlation of knowledge with access and confidence supports the important role EBP training has in education. The positive correlation between attitude, access and confidence supports previous studies that have shown that attitude can have an impact on EBP access or utilization.[32-34] The significant difference in knowledge and confidence scores depending on degree level obtained indicates that additional education may

provide more opportunities to gain EBP knowledge, which in turn can impact utilization of EBP principles into dental hygiene curricula. The positive relationship between increased knowledge and confidence and the highest degree offered by the respondents' teaching institution may be a result that faculty teaching at those institutions may hold a higher degree level, therefore, may possess additional EBP education. Also, it appears that those who have more experience teaching as well as possessing an advanced degree to teach didactic courses have increased levels of access of evidence-based literature and confidence in applying EBP principles. This may be a result of additional opportunities to gain experience with EBP as well as incorporating it into dental hygiene curricula.

Limitations

There are limitations in this study that may affect the generalization of the results. The study had a low response rate and the authors are not clear on the total number or population of full and part-time faculty in U.S. entry-level dental hygiene programs. There is the potential for bias with a convenience sample and small response rate that could impact whether the results are representative of all U.S. dental hygiene educators. Another limitation is that volunteerism bias may exist since those that chose to respond may possess fundamentally different EBP knowledge, attitudes and confidence than those that chose not to participate. Therefore, additional research is necessary that includes a stratified randomized sample representing various U.S. dental hygiene programs geographically as well as educators of varying teaching appointments and types of programs they teach. Caution interpreting the study results should also be taken, since the questions in the KACE assessment regarding prevalence and occurrence may not have been worded clearly.

CONCLUSION

Overall, survey results from this study indicate U.S. dental hygiene educators' have varying knowledge, access of evidence and confidence in the use of EBP. The study showed dental hygiene educators possess knowledge regarding levels of scientific evidence, PICO and analyzing research study results, however, knowledge of certain statistical terms were lacking. The limited knowledge of statistical terms may affect the ability to correctly interpret and apply study results to patient care. The positive association between degree level obtained and EBP knowledge, access to evidence and confidence may have an impact on incorporation of EBP into dental hygiene curricula and the ability to teach EBP principles impacting dental hygiene students' acquisition of EBP principles. Therefore, additional training for dental hygiene educators may be necessary to improve knowledge, access and confidence utilizing EBP principles. Since years of teaching was positively related to access and confidence as well, additional educational EBP opportunities may be necessary to improve confidence and access of EBP. Ultimately, educators must possess adequate EBP skills in order to incorporate EBP into dental hygiene curricula, teach EBP and feel confident in doing so.

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Students' Perceptions of Teaching Methods That Bridge Theory to Practice in Dental Hygiene Education

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Abstract

Purpose: Health care education requires students to connect classroom learning with patient care. The purpose of this study was to explore dental hygiene students' perceptions of teaching tools, activities and teaching methods useful in closing the gap between theory and practice as students transition from classroom learning into the clinical phase of their training.

Methods: This was an exploratory qualitative study design examining retrospective data from journal postings of a convenience sample of dental hygiene students (n=85). Open-ended questions related to patient care were given to junior and senior students to respond in a reflective journaling activity. A systematic approach was used to establish themes.

Results: Junior students predicted hands-on experiences (51%), critical thinking exercises (42%) and visual aids (27%) would be the most supportive in helping them connect theory to practice. Senior students identified critical thinking exercises (44%) and visual aids (44%) as the most beneficial in connecting classroom learning to patient care. Seniors also identified barriers preventing them from connecting theory to patient care. Barriers most often cited were not being able to see firsthand what is in the text (56%) and being unsure that what was seen during clinical practice was the same as what was taught (28%).

Conclusion: Students recognized the benefits of critical thinking and problem solving skills after having experienced patient care and were most concerned with performance abilities prior to patient care experiences. This information will be useful in developing curricula to enhance critical thinking and problem solving skills.

Keywords: theory-practice gap, students' perspective, reflective journaling, teaching methodology, clinical practice

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

Health care education requires development of curricula that incorporate classroom learning with clinical practice. Since many health care disciplines involve clinical treatment, it is necessary for students to have an opportunity to practice skills involving application of these treatments. For treatments to be successful, students must understand the reasons, purposes and histories behind them, as well as, the biological, chemical and physical properties involved with them.[1-4] This understanding is considered the theory behind the practice. Once the understanding of the theory is developed, the practical skills of the treatment process can be introduced. Often this introduction is in a controlled clinic or laboratory where students utilize forms of simulation to practice these skills under direct supervision.[5-7] This gives the students the opportunity to practice these skills while trained instructors provide feedback for skills enhancement.[6,8,9] Eventually the students enter the clinical environment to put these skills to work in a real life scenario.

As students progress from the classroom setting to the clinical setting, the connection between the two is often missed.[1-3] This is known as the theory-practice gap (TPG). Understanding theory behind practice allows students to connect and apply their knowledge to react in unforeseen situations and will result in better patient outcomes.[1,3] Without the connection between theory and practice, the student becomes anxious, confused and loses confidence when faced with difficult clinical situations.[10] As a result, it is important for educational institutions to reduce the theory-practice gap before introducing students to clinical experiences.

To help make the connection between theory and practice, teaching methods have been developed to improve critical thinking skills and increase confidence levels during the clinical phase of learning.[3,4,11-13] As a student becomes familiar with processes of clinical practice and can rephrase the purposes behind each action, the action becomes more automatic and

involves less cognitive processing.[3,4,14-16] In situations where the scenario is unfamiliar, the student is required to bounce back into cognitive control that allows a more thought provoked response to formulate a new course of action which is an adaptation of the original.[14-16] This practice is necessary in many health care settings, since patient care can often be unpredictable and vary considerably from the norm. It requires critical thinking and an understanding of the purpose behind the action to develop a modified plan to address the individual patient's needs.[12,15]

Little research exists to specifically define the teaching methodology useful in bridging the knowledge gained in the classroom with its usefulness in the clinical setting.[17] Although many studies have been developed to address the TPG,[2-4,6] little is known about how this impacts psychomotor skills development and successful treatment applications. A gap also exists in the research identifying learning methods to reduce the TPG and improve students' ability to relate classroom learning to clinical practice. Another missing piece is the identification of barriers students perceive as preventing them from making this connection.

The purpose of this study was to investigate students' perceptions of the teaching strategies currently used in theoretical learning and their impact on connecting theory to practice as students transition into the clinical phase of their training in dental hygiene education. In addition, the study identified perceived barriers impacting students' ability to make this connection.

Methods and Materials

The Institutional Review Board granted permission to conduct this study. Based on the established educational practices in normal educational settings, the status of "exempt" was given in accordance with 45 CFR 46.101.

This was an exploratory qualitative study design examining retrospective data from journal postings of a convenience sample of dental hygiene students (n=85). Dental hygiene was the chosen discipline studied as it requires significant psychomotor development, patient care and the ability to connect knowledge with practice.

Retrospective data from students' Blackboard Learn™ journal postings of the junior (n=67) and senior (n=18) classes enrolled in the Baccalaureate of Science dental hygiene program were obtained. All student participants were informed of the use of their journal postings for research prior to data collection. All personal identifiers were removed from data prior to delivery to the principal investigator (PI) to protect student confidentiality.

Students were asked to respond to open-ended questions relating to their clinical dental hygiene experiences and were given 1 week to post responses in a journaling reflective practice through their Blackboard Learn™ accounts. The journal postings were related to reflections on clinical dental hygiene practice and were collected from 2 time points: prior to beginning patient care and at the end of the clinical curriculum prior to graduation. Data was copied and pasted into a Word document from Blackboard Learn™ by an administrative assistant.

Survey Instrument

The journaling prompt provided to the junior class prior to clinical experience was the following:

- What learning tools, activities and teaching methods introduced since entering the dental hygiene program and/or previous learning experiences are going to help you connect what you have learned in the classroom to providing patient care in the clinic?

The journaling prompts provided to the senior class at the end of the clinical curriculum was the same along with the following additional question:

- What barriers, obstacles or other things hindered your ability to connect classroom learning to your clinical patient care experiences?

Journaling prompts were developed and reviewed by an expert panel of faculty. To assure students had a good understanding of the journal prompts; 4 dental hygiene students piloted the questions. These 4 students did not participate in the actual study.

A thematic analysis, using a data driven inductive approach to develop themes and interpret the results, was established.[18] Themes were developed through careful reading and rereading of the data.[18] This established patterns associated with the data that emerged into themes.[18] Relevant and useful findings were formulated into thematic categories to further classify the data.[17,18]

A systematic approach was developed to establish useful items by underlining and highlighting potential patterns.[18] Once patterns were recognized, themes began to surface directly from the students' postings.[18] Themes were given codes to categorize and classify the data.[18] Further analysis involved applying codes to each data item.[18] This helped to establish relevance of material and understanding of the findings.

Each code was tallied and a percentage was calculated to determine frequency of response. This illustrated the most common perceived tools, activities or methods influential in bridging the gap between class-

room learning and clinical practice in the students studied. Data was evaluated in terms of juniors or seniors and a comparison was made. There was also an evaluation of perceived barriers that influenced students' ability to connect theory with practice.

RESULTS

Many students listed several items that influenced their ability to make the connection between classroom learning and patient care. The junior class (n=67) had a response rate of 87% of usable data. Table I displays the collected data, 1 response was unrelated to the question and not included in the study. Hands-on activities was reported 50.7% of the time as having the greatest influence aiding students in connecting classroom learning with patient care. Many of the students specified hands-on activities as clinical experiences with a partner or the opportunity to practice a skill in a simulation-type atmosphere. Several students mentioned having the opportunity to practice a dietary analysis or completion of a clinical assessment on a patient, as contributed to making the connection.

Examples of statements referencing hands-on activities contributing to students' ability to connect classroom learning with patient care are the following:

"To me, the best learning method or technique is 'learning by doing' and being able to see it in action. The best way to learn anything, in my opinion, is to apply the knowledge in real life scenarios."

"In other words, making the connection from the books to the patient chair in my perspective can only be done through hands-on experience."

The junior class also identified critical thinking activities as potentially contributing to connecting classroom learning to patient care. As many as 41.8% of students made reference to case studies or other thought provoking activities as the second most common response. Visual aids were the third most common activity or tool named, with as many as 26.9% of the students referred to videos, internet links and handouts as potential tools that would aid them in making the connection.

Examples of quotes referencing critical thinking activities are the following:

"For me, I really like the case studies we do in class. It gives me the opportunity to apply some things we have learned in class in a semi-clinical setting."

"……in helping me connect things I learn in class to what I will be doing or seeing in clinic are the case studies we have done. Those case studies have pro-

Table I: Qualitative Data from Junior Class Journal Responses with Their Ideas of Learning Tools, Activities and Teaching Methods That Will Be Beneficial in Connecting Classroom Learning to Clinical Practice

	Junior Class Responses	Number of responses in category	Percentage
1	Hands-on Experiences	34	51%
2	Critical thinking exercises	28	42%
3	Visual Aids	18	27%
4	Peer-to-peer relationships	7	10%
5	Study Groups	9	13%
6	Peer-to-peer relationships/Study Groups	16	24%
7	Collaborations with Faculty/feedback	15	22%
8	Specific course-work	17	25%
9	Previous Experiences (work, education)	12	18%
10	Miscellaneous		<10%

vided us with numerous possible scenarios of what we could be seeing and it also gave us an opportunity to discuss treatment …"

Examples of quotes referencing visual aids are the following:

"…it definitely made more sense seeing it done on the videos…"

The junior class recognized peer-to-peer collaborations in 10% of the responses and 13.4% made reference to study groups. The combination of these 2 categories resulted in 23.8% of the students referring peer-to-peer collaborations, peer-to-peer discussions and study groups as having a strong influence on their ability to connect theory to practice. Because study groups involve peer-to-peer collaborations, they were identified separately and combined with peer-to-peer collaborations. Collaborations with faculty were also identified by 22.4% of the junior students. Many stated the continuous feedback given by the instructors would help them make this connection during patient care sessions.

Examples of quotes referencing peer-to-peer collaborations are the following:

"…with a student partner and even sitting as patient

I learned a lot by just listening and learning new things from what my clinician did."

"What has also helped me connect one thing to another was studying with other students in class. When I studied with fellow colleagues, sometimes they bring up ways to remember things easier."

Examples of quotes referencing faculty support are the following:

"The instructors inside and outside of the classroom have been encouraging and incredibly helpful…"

"Another tool that has helped me connect what I learned in the classroom to providing patient care in the clinic is the faculty feedback after each lab."

Several specific courses were acknowledged by 25.3% of the junior students as contributing to their ability to make the connection. Previous work or educational experiences were also referenced in 17.9% of the responses. Some students had previous experiences working in dental practices and others had unrelated work experiences they felt contributed to their ability to make the connection. Other items were identified by less than 10% of the students.

Examples of quotes referencing specific coursework are the following:

"…taking radiology class has taught much more, like how to measure bone loss and calculus detection."

"…I learned SO much in dental materials last semester."

Examples of quotes referencing previous work or education experiences are the following:

"I have held many part-time jobs throughout high school where I learned how to interact with all different types of people, be responsible, professional and dependable."

"…from my assisting experience in high school…"

"I think that my experience working in the business world (developing projects, implementing them, dealing with angry customers, fixing other people's mistakes and - this is huge – managing weird/unpleasant personalities) has prepared me for life in the clinic."

Figure 1 displays a graph comparing the frequency of the junior class responses.

Figure 1: Junior Class Results to Open-Ended Question
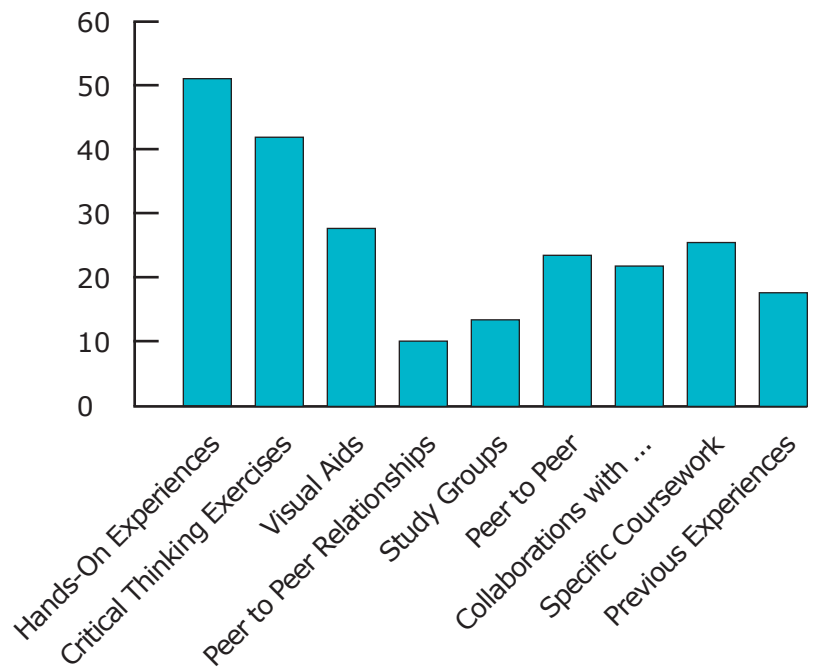
Question: What learning tools, activities and teaching methods introduced since entering the dental hygiene program and/or previous learning experiences are going to help you connect what you have learned in the classroom to providing patient care in the clinic?

The senior class results were analyzed separately. The senior students (n= 18) had a response rate of 64%. All collected data was utilized and tallied and results are displayed in Table II.

Themes identified from the data resulted in 44% of the students stating critical thinking exercises such as case studies and visual aids were the most useful tools in connecting classroom learning to patient care. Other responses included 17% of the seniors reporting hands-on activities as the most useful and 11% finding study groups as the most beneficial and these results vary slightly from the junior class results.

Examples of quotes from the senior students that found critical thinking exercises are as follows:

"The case studies we have done in various classes have definitely been beneficial through hygiene school…they were helpful for providing patient care because you will see many of these case study scenarios in real life."

"These case studies show us different cases, some of which we may not see in clinic."

Examples of quotes from the senior students that found visual aids as most useful are as follows:

"…I found to be very helpful was online videos."

Table II: Qualitative Data from Senior Class Journal Responses Establishing the Learning Tools, Activities and Teaching Methods That Have Helped Them Make the Connection between Classroom Theory and Clinical Practice

	Senior Class Responses	Number of responses in category	Percentage
1	Critical thinking Exercises	8	44%
2	Visual Aids	8	44%
3	Hands-on Exercises	3	17%
4	Peer-to-peer relationships/ Study Groups	2	11%
5	Miscellaneous		<10%

"The learning tools that have helped me in providing care in clinical setting are video tutorials"

"…having the clinic sheets and the process of care sheets…"

Examples of quotes from the senior students that found hands-on exercises or experiences as most useful are as follows:

"I feel that the best way to learn is to actually do it and experience it firsthand."

"One activity stuck out to me, a professor gave us mazes and told us to do it through the mirror to help with our indirect vision and I felt as if it really helped me."

Examples of quotes from the senior students that found study groups as most useful are as follows:

"I think seminar was a great help to be able to get together as a group and ask clinical questions outside of clinic."

Figure 2 displays a graph comparing the frequency of the senior class responses to the first open-ended question.

The senior class was also asked to identify barriers, obstacles or other things that prevented them from making the connection between classroom learning and patient care. Themes were identified from the data and the results are displayed in Table III.

The most common theme identified as a barrier (56%) was not being able to see firsthand what was being taught in class or in the text. The second most

Figure 2: Senior Class Results to First Open-Ended Question
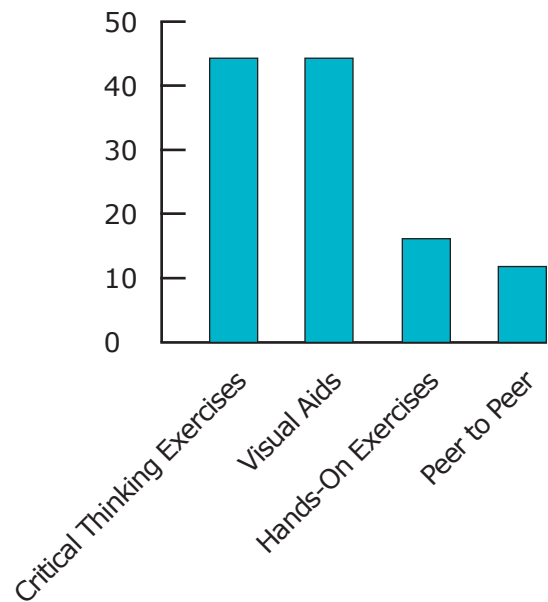
Question: What learning tools, activities and teaching methods introduced since entering the dental hygiene program and/or previous learning experiences have helped you connect what you have learned in the classroom to providing patient care in the clinic?

common theme identified as a barrier (27% of the students) was being unsure that what was learned matched what was being seen.

Examples of quotes from the senior students referring to the theme of not being able to see firsthand what was being taught are as follows:

"Seeing the pictures in the book was very helpful, but it's not the same as seeing it firsthand clinically."

"Not being able to ever see certain conditions or diseases that we learn about in the classroom and hope or expect to see it in the clinic and don't get to I feel is a barrier."

Examples of quotes from the senior students referring to the theme of being unsure what was learned matched what was being seen are as follows:

"We have learned different conditions a patient can have, but trying to determine whether a patient has a chronic or acute gingivitis or periodontitis and whether they may need NSPT can be challenging."

"The hardest obstacle I found was just figuring out a way to connect everything because classroom and clinical is so different."

Figure 3 displays a graph comparing the frequency of the senior class responses to the second open-ended question.

Table III: Qualitative Data from Senior Class Journal Responses Identifying Barriers and Obstacles That Prevented Them from Connecting Theory to Practice

|	Senior Class Identified Barriers	Number of responses in category	Percentage
1	Unable to see first-hand what we learn in classroom and text	10	56%
2	Unsure what we learned matches what we see	5	28%
3	Miscellaneous items	3	16%

DISCUSSION

The results of this study identified the differences in students' perspectives of learning tools beneficial in helping them make the connection between classroom learning and patient care in dental hygiene education. Prior to entering into clinical practice with live patients, students perceived their hands-on experiences as the most beneficial activity in helping them make the connection between what they had learned and what they were doing. Following live patient experiences, students' perceptions of what aided them changed; they recognized critical thinking activities and visual aids were most beneficial in helping them make the connection between classroom learning and patient care.

As students begin to transition into clinical practice their responses demonstrated greater concern with performance. However, after gaining more experience with patient care, the responses changed and students began to recognize the importance of being able to apply what they had learned to what they are doing.

The senior students identified perceived barriers that prevented them from connecting their classroom learning with their patient care. Many students recognized live patient experiences as being different from what they had encountered in the classroom or in simulation practice. Recognizing this difference contributed to their ability to better prepare for variations from the norm that they encountered in clinical practice. Many students emphasized the fact that what was seen in the textbook didn't always match what they saw in the clinic and several students added they would have liked to have had more firsthand experience with the potential varia-

Figure 3: Senior Class Responses to Second Open-Ended Question
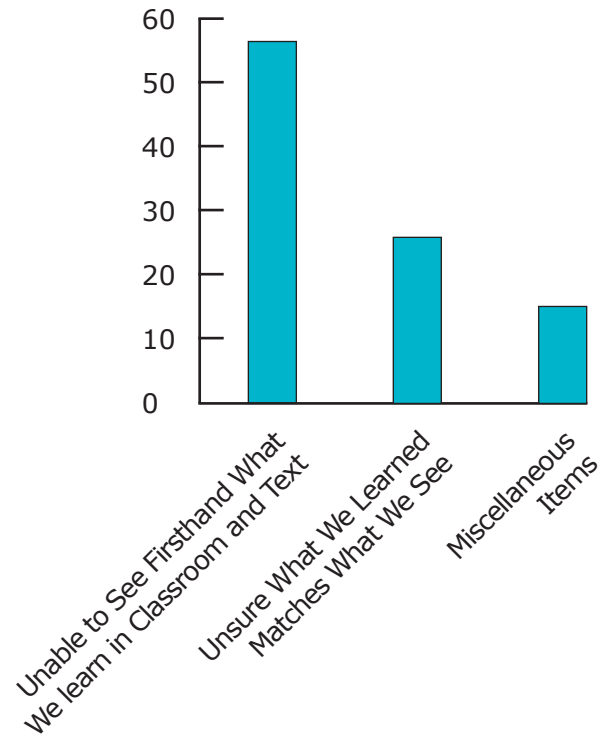
Question: What barriers, obstacles or other things hindered your ability to connect classroom learning to your clinical patient care experiences?

tions. Because students encountered unknowns or variations of what was taught in the classroom, they questioned their understanding of what they were seeing in actual patient care situations.

Previous research has identified confidence levels, stress and anxieties as the greatest barriers preventing students from making the connection between classroom learning and clinical practice.[10,13,17,19] Although, students in this study did not recognize these things as barriers, they did make reference to the inconsistency of what is taught in the classroom and what is seen in clinical practice as being a barrier. Corlette et al,[1] Ferguson et al,[2] Baxter[3] and Rolfe[12] identified the unpredictable nature of health care resulting in unforeseen events in clinical practice as a contributing factor in making the connection between theory and practice. The unknown or ambiguity of patient care in health care could be contributing to overall stress, anxiety and confidence level in the students and could be a potential underlying barrier that was not apparent in this study.

Many studies have attempted to identify learning strategies and teaching methods useful in preventing barriers that contribute to the TPG.[3,15,20] While others have recognized the impact the TPG has on a student's ability to determine the proper course of action during unforeseen events.[19,21-23] Reflec-

tive activities, the use of a mentor or preceptor and problem-based learning are among the strategies previously recognized.[11,12,14-16,21,24-26] In this study students identified hands-on experiences, critical thinking activities and visual aids as the most useful strategies for bridging the classroom to practice gap. The strategies identified in the literature reinforced building critical thinking and problem solving skills in bridging the TPG and this is aligned to what students in this study found as helpful when beginning live patient experiences.[11,21,26] Prior to live patient experiences students predicted hands-on experiences and visual aids would be most helpful, however, once students gain more clinical experience, their perceptions of what educational strategies benefited them changed.

The greatest limitation of this study was the use of a single institution and one program of study. Another limitation is the data analysis; the qualitative nature of the study required some interpretation of the data with some of the responses being vague and difficult to categorize. However, with the use of coding and categorization to identify themes, the interpretation was done uniformly and consistently. Lastly, it is possible that students' learning style may have impacted the perceived barriers listed by the students.

CONCLUSION

This study identified learning strategies most useful to students in bridging the gap between classroom learning and clinical practice from the students' perspective. Students perceived hands-on activities and visual aids as being most helpful prior to live patient experiences. Following more experience with live patient care, the strategies perceived by the students as being helpful changed as the senior students recognized the benefits of being able to problem solve when faced with unexpected events in clinical practice. Curricula that encourage students to utilize all available tools for strengthening critical thinking and problem solving skills will improve learning outcomes in health care education. Further studies identifying students' perceptions of strategies that increase these skills will provide another means to improve health care curricula.

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RESEARCH

Volunteerism among Dental Hygienists: The Relationship between a Practice Act Incentive, Behaviors, Perceptions and Motivational Orientations

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Abstract

Purpose: Thirteen states in the nation authorize dental hygienists to satisfy re-licensure requirements in part, by performing pro bono oral health services in lieu of participating in continuing education courses This study compared registered dental hygienists' donations of time and professional expertise, perceptions of volunteerism and motivational orientations as they practice in both the presence and absence of a practice act statute intended to incentivize volunteerism.

Methods: Volunteer behaviors, perceptions and motivational orientations of a non probability sample of 316 dental hygienists actively licensed by the states of Idaho or Utah, were assessed using an online survey which included the Self Determination Theory General Causality Orientations Scale (GCOS). Survey Monkey results were analyzed using Mann Whitney U tests, Chi-Square analysis and an Independent Samples t-test at the 0.05 level of significance.

Results: No statistically significant differences were found between dental hygienists' volunteer behaviors, perceptions of volunteerism or scores on the GCOS Autonomy and Impersonal subscales in the 2 states studied. Statistical analysis of dental hygienists' mean scores on the GCOS measure of Controlled motivational orientation yielded a significant difference (p=0.001) among Utah and Idaho dental hygienists.

Conclusion: Dental hygienists require evidence based practice statutes and regulations that keep pace with the need to provide universal access to comprehensive oral care. Additional research is required to determine the effectiveness of legislation intended to encourage registered dental hygienists' altruistic expressions. Dental hygienists are frequently unaware of opportunities to volunteer their services and how state practice act regulations impact those opportunities.

Keywords: volunteerism, dental hygienists, practice acts, motivations, incentives, self determination theory, general causality orientations scale

This study supports the NDHRA priority area, **Health Services Research:** Identify how public policies impact the delivery, utilization, and access to oral health care services.

INTRODUCTION

The failure of the nation's infrastructures to satisfy the oral health needs of isolated, underprivileged or impaired populations is well documented.[1-7] In response to these needs, many state dental boards have organized volunteer systems and ratified practice act provisions that encourage dentists and dental hygienists to provide services to disadvantaged and underserved populations within their communities.[6-17] Some licensing boards have relaxed or suspended direct supervision requirements allowing oral health professionals unencumbered access to needy populations.[11-14] In other regions, state officials offer reduced or no cost volunteer licenses to dentists and dental hygienists willing to provide charitable care to underserved populations in qualified locations.[8,11-13,16] A few states also provide liability insurance and legal protection for dental professionals when they volunteer.[17]

In select states, providing pro bono care or freely presenting oral health education to indigent or critical need populations through nonprofit agencies and organizations are options for satisfying the continuing education requirements necessary for oral health professionals to demonstrate continued professional competence.[9,13,14,16,18,19] Under these circumstances, dentists and dental hygienists can apply their professional expertise while benefiting those in need. Cultural competence is enhanced when services are provided to diverse populations in nontraditional settings. In this sense, volunteering in a professional capacity closely parallels the outcomes of academic service learning.[20]

Of the states requiring continuing education as a condition to maintain a license to practice dental hygiene, thirteen presently recognize specified volunteer activities as a suitable alternative to educational course work.[9,10] Arizona, Delaware, Florida, Georgia,

Idaho, Illinois, Minnesota, Nevada, Ohio, Oklahoma, Oregon, South Dakota and West Virginia, all afford dental hygienists the option of performing a specified number of volunteer hours per licensing cycle to satisfy between 1 to 10 hours of the requisite number of continuing education hours.[9] To alleviate deficiencies in the existing health care system, it is important for state professional licensing boards to understand exactly how and to what extent, authority can be used to successfully engage dental hygienists in community service activities. Despite extensive exploration of this subject area, the phenomenon of volunteerism has been understudied in populations comprised specifically of dental hygienists. There is limited understanding of the factors which contribute to the decision of dental hygienists to volunteer professional services to the disadvantaged and underserved. A solitary investigation designed to evaluate this populations' views of mandatory requirements for community service was conducted by Bhayat et al among South African oral hygienists.[21] They concluded, stringent mandates can engender negative attitudes toward humanitarian service, and ultimately be counterproductive to their intended purpose.[21] Similar outcomes were reached by comparable investigations, conducted among populations other than dental hygienists.[21-26] Researchers have found community service mandates can engender negative attitudes toward humanitarian service and ultimately be counterproductive to the intended purpose.[21-26] Legislation designed to effectively promote volunteerism, must ensure "volunteers" have the individual freedom to decide when, where and how long the service will continue.[21-25]

According to the Self-Determination Theory (SDT) of human motivation and behavior, the ideal environment for responsible behaviors such as volunteering to take root and flourish, are those that ensure autonomy while allowing for the interaction of both intrinsic and extrinsic influences.[26,27] In addition to addressing both intrinsic and extrinsic motivations, the constructs of SDT account for the role external forces and social contexts play in facilitating desirable and responsible behaviors such as volunteering.[26-31]

The basic premise of SDT is that human beings are naturally prone to intrinsic or autonomous motivation and self-regulation which are the sources of personal creativity, accountability, well-being and lasting change.[30-32] Depending upon one's unique response to various environmental factors, an individual's motivational orientation may be controlled to various degrees by external forces.[27] Deci and Ryan consider people dominated by extrinsic rewards, punishments or the expectations of others to have controlled motivational orientations.[33] Others feel ineffective, even helpless or are simply content to maintain the status quo.[30-33] In terms of SDT, such individuals are amotivated and have an impersonal motivational orientation.[33] The instrument designed by Deci and Ryan to

measure these subscales of personal motivation is the General Causality Orientations Scale (GCOS).[30-33]

If dental hygienists are predominantly motivated by intrinsic forces to provide pro bono services, it is possible that an occupational licensing provision intended to ignite and fuel volunteer activity amongst this population may actually extinguish existing intrinsic or internal motivations for prosocial behaviors.[27] Conversely, for dental hygienists who respond to external incentives or who are amotivated, a state authorized benefit may kindle personal desires to provide volunteer service.[27]

Volunteering is a complex prosocial phenomenon that defies simple classification. For the purposes of this research, volunteerism was defined as: dental hygienists choosing to provide educational or therapeutic methods to prevent or treat oral diseases and promote oral health "in recognition of a need, with an attitude of social responsibility and without concern for monetary profit, going beyond one's basic obligations."[34,35]

The individuals identified as being most likely to volunteer are middle aged, female, college graduates, who earn above average levels of income.[36-38] As the demographic profile of a volunteer is compared to the group characteristics of dental hygienists, it is clear, these oral health professionals possess both the personal assets and resources that enable them to volunteer.[39] An early investigation of prosocial practices conducted among graduates of the University of Iowa's dental hygiene program, Hunter found 57% of this population rendered some type of volunteer service annually.[40] Marsh's 2011 exploration of volunteerism among licensed New York dental hygienists determined 57.4% of dental hygienists volunteered in a professional capacity at least annually.[35] Based upon data for the year 2010, only 26.3% of the general population in the U.S. volunteers.[41] According to the 2007 American Dental Hygienists' Association (ADHA) survey, 45.2% of dental hygienists report involvement in some type of volunteer activity related to the profession.[39] Although the volunteer rate is considerably higher than that of the overall population, almost half of the dental hygienists in this country do not volunteer.[39]

The implications of permitting dental hygienists to satisfy re-licensure requirements by performing donated oral health services have not been investigated. While crediting or "rewarding" oral health professionals with continuing education hours for the performance of prosocial acts seems to be an ideal strategy to sustain and improve the rate of volunteerism, there is no empirical support for this arrangement. This research compared the donations of time and professional expertise, perceptions of volunteerism and motivational orientations of dental hygienists when they

volunteer professional services in both the presence and absence of a practice act statute intended to incentivize volunteerism.

Methods and Materials

Upon approval from the Idaho State Human Subjects Committee a quasi-experimental, non-equivalent control group design was used to test the null hypotheses of no differences in the dependent variables of volunteer hours performed; individual perceptions of volunteerism; and, dominant motivational orientations among dental hygienists. The target population was 3,717 registered dental hygienists from 2 neighboring geographical locations, with very similar environmental, economic and demographic characteristics. The major distinguishing feature was a difference in state regulation of continuing education requirements and volunteer hours.

Forty-eight states in the nation require continuing education as a condition for professional license renewal.[10] The state of Utah is 1 of 35 that does not currently recognize volunteer activities as an indication of continued competence.[9] Alternatively, Idaho accepts volunteer service as a form of continuing education.[9] Registered dental hygienists endorsed by the states of Utah and Idaho were also selected as the cohorts for this research because in a state by state comparison of volunteer rates, these 2 regions were ranked proportionally, first and second highest in the nation.[41]

With the support of both state dental hygiene professional associations, information procured from the state licensing boards, emails, text messages and postcards were sent to actively licensed dental hygienists in Utah and Idaho. These communications invited them to participate, presented the purpose of the study and outlined procedures for accessing and completing an online survey. The software, Survey-Monkey® was used to document participant consent and collect the information required to address the research questions.

The online survey was comprised of a combination of numerical, close-ended questions and semantic differential rating scales. The survey features were designed to assess the population's descriptive characteristics, volunteer behaviors perceptions of volunteering.

The content and face validity of these aspects were substantiated by specific literature citations.[23,36,42-51] The SDT General Causality Orientations Scale (GCOS) was used to assess the strength of 3 distinct motivational orientations among the study population.[33] Twelve items presented hypothetical sketches and provided 3 possible reactions to each situation described. The 3 subscales for each mea-

sure corresponded to an Autonomy, Controlled or an Impersonal Motivational Orientation. The stability and reliability of the research instrument was evaluated using test-retest reliability and a coefficient of 0.83 was achieved. At the conclusion of the 5-week survey period, the data collected was exported from SurveyMonkey®, quantified and statistically tested with a significance level of 0.05.

Results

Four hundred and twenty-eight (11.5%) dental hygienists actively licensed by the states of Utah and Idaho responded to the survey. Of the total number of survey respondents, 316 participants provided usable study data.

The majority of respondents were female, between the ages of 21 to 40 years with dependents. Two-thirds of the study participants were licensed to practice in Utah while one-third were licensed in Idaho. The plurality of respondents worked part-time, had between 1 to 9 years of professional practice experience and attained a baccalaureate or graduate degree. Almost two-thirds of the respondents were not members of the American Dental Hygienists' Association. Nearly half (45.2%) of the dental hygienists surveyed were uncertain if time spent volunteering professional services was an option for satisfying some of the continuing education hours required for professional licensure renewal.

The inclinations of registered dental hygienists to volunteer in a professional capacity appear in Table I. Although Utah dental hygienists seemed somewhat more willing to volunteer services to underserved populations when compared to Idaho dental hygienists, Mann Whitney-U analysis of this dimension revealed no statistically significant difference in the willingness of dental hygienists to volunteer.

Study participants were asked how many hours were typically spent providing pro bono oral health services each year. As evidenced in Table I, dental hygienists in the state of Utah volunteered in a professional capacity a mean of 51.9 hours annually and in the state of Idaho 15.4 hours annually. Comparing the pro bono hours of professional dental hygiene service in the most recent twelve-month period, the mean number for those licensed by the state of Utah was 20.4 hours. For those licensed by the state of Idaho the number was 17.8 hours. Mann Whitney U tests were conducted on both measures of time spent volunteering in a professional capacity. The results revealed no statistically significant difference in the number of hours volunteered in a professional capacity when the practice occurred in a state where volunteer service is sanctioned by the dental licensing board as compared to when they practice occurred in a state that does not permit

Table I: Inclinations to Volunteer and Pro bono Hours

		Inclinations to Volunteer	Pro bono Hours Annually	Pro bono Hours This Year
Idaho	Mean	4.2	15.4	17.8
	Median	4.00	6.00	5.00
	Standard Deviation	-	23.757	59.695
	N	108	108	109
	Mean Rank	152.70	160.68	162.88
Utah	Mean	4.3	51.9	20.4
	Median	4.00	5.00	5.00
	Standard Deviation	-	243.753	66.039
	N	206	206	206
	Mean Rank	160.01	155.83	155.42
Total	Mean	4.2	39.4	19.5
	Median	4.00	5.50	5.00
	Standard Deviation	-	198.517	63.831
	N	314	314	315
Test Statistic	Mann-Whitney U	10606.00	10781.00	10695.00
	p	0.457	0.651	0.482

some measure of volunteer service to satisfy re-licensure requirements.

A summary of dental hygienists' attitudes regarding the importance of volunteerism as well as the significance of certain personal, motivational, and situational antecedents of volunteer behaviors appear in Table II. According to this table, dental hygienists in both states strongly affirmed the importance of volunteerism as a means of meeting unmet oral health needs or improving access to oral health care. Both Utah and Idaho dental hygienists categorically acknowledged the opportunity to serve within local communities was a personally meaningful, positive, intrinsically rewarding experience and promoted a positive public perception of the profession. Disagreement with extrinsically rewarding dental hygienists for prosocial efforts was a prevailing theme among all respondents. Utah dental hygienists indicated slightly stronger agreements for the statement, 'Practice act requirements for the direct or general supervision of dental hygiene functions are a deterrent to dental hygienists volunteering in a professional capacity.' Mann Whitney U analysis of the mean ranks of disagreement or agreement with statements relative to volunteerism revealed no statistically significant difference between dental hygienists licensed in the 2 states of interest.

The survey instrument asked dental hygienists to select the factor most likely to prevent volunteering professional services. Over 80% identified time constraints due to family, work or school obligations as the main obstacle to involvement in volunteerism. The remaining respondents (18.9 %) indicated a lack of volunteer opportunities as the leading cause of non-participation in oral health service activities. Chi Square analysis of the nominal data collected revealed views of barriers to volunteerism were not significantly different between dental hygienists licensed by the states of Utah and Idaho.

Of the factors most likely to incite dental hygienists to participate in oral health service activities, 44.1% of respondents identified credit hours to satisfy state professional licensing requirements as the most motivating factor. State licensing endorsements were cross tabulated with data identified motivating factors: a sense of personal satisfaction, opportunities for professional development, social networking opportunities, community approval or recognition and credit hours to satisfy state professional licensing. Chi Square analysis of this nominal data revealed dental hygienists licensed by the states of Idaho and Utah did not have significantly different perceptions of the factors most likely to incite volunteer behaviors.

Study participants were asked to consider the reasons dental hygienists might volunteer in a professional capacity. As shown in Table III, more dental hygienists in the state of Idaho as compared to the state of Utah, felt the opportunities to learn something new and earn credit hours to satisfy licensing requirements were extremely important motives for providing pro bono services. Idaho dental hygienists also had higher rankings with regard

Table II: Personal Opinions of Volunteerism

Volunteerism	State Endorsement	n	Mean	Median	Mean Rank
Promotes a Positive Public Perception of the Profession	Idaho	108	4.5	5.00	164.17
	Utah	207	4.4	5.00	154.78
	Total	315	4.4	5.00	
Should be Extrinsically Rewarded	Idaho	108	2.4	2.00	166.49
	Utah	207	2.3	2.00	153.57
	Total	315	2.4	2.00	
Requirements for Direct or General Supervision Hinder	Idaho	109	3.5	4.00	147.64
	Utah	207	3.7	4.00	164.22
	Total	316	3.6	4.00	
A Reward In and of Itself	Idaho	109	4.4	5.00	167.54
	Utah	206	4.3	4.00	152.95
	Total	315	4.4	4.00	
Meets Unmet Oral Health Needs	Idaho	109	4.2	4.00	165.24
	Utah	206	4.1	4.00	154.95
	Total	315	4.1	4.00	
A Positive Experience	Idaho	109	4.4	5.00	159.18
	Utah	207	4.5	5.00	158.14
	Total	316	4.5	5.00	
Personally Meaningful/ Satisfying	Idaho	109	4.5	5.00	160.06
	Utah	206	4.5	5.00	156.91
	Total	315	4.5	5.00	

Volunteerism	Mann-Whitney U Test	p
Promotes a Positive Public Perception of the Profession	10512.00	0.324
Should be Extrinsically Rewarded	10261.500	0.209
Requirements for Direct or General Supervision Hinder	10097.500	0.109
A Reward In and of Itself	10187.500	0.134
Meets Unmet Oral Health Needs	10546.500	0.305
A Positive Experience	11207.00	0.913
Personally Meaningful/Satisfying	11003.00	0.741

to volunteerism being a societal obligation and a competency requirement, expectation or option. Alternatively, more Utah dental hygienists viewed the opportunities to meet new people, enhance one's resume and find a meaningful use of discretionary time as extremely important reasons to volunteer. Mann Whitney U analysis of the mean ranks of the importance of statements concerning the causes of volunteerism revealed there was no statistically significant difference between dental hygienists licensed in these 2 states.

The SDT GCOS was used to assess the strength of 3 distinct motivational orientations among the study population.[33] Differences in the sample sizes for the comparisons occurred between the 3 sub-scales as not every study participant completed all survey items in this section.

Group statistics for the GCOS data set were calculated and Table IV provides the results of this statistical analysis. Although the measures of Autonomy, Controlled and Impersonal Motivational Orientations were ordinal in nature, the overall scores of these subscales were the sum of 12, 7-point Likert scales. Therefore, the GCOS scores were treated as continuous variables and a parametric independent samples t test was used in the comparison of the mean GCOS scores of respondents.

Prior to conducting the independent samples t test, to ensure the 2 variances on each subscale

Table III: Reasons for Volunteering

Volunteering	State Endorsement	N	Mean	Median	Mean Rank
An Opportunity to Learn Something New	Idaho	108	3.8	4.00	159.56
	Utah	207	3.7	4.00	157.19
	Total	315	3.7	4.00	
An Opportunity to Earn Credit Hours to Satisfy Professional Licensing Requirements	Idaho	109	3.9	4.00	163.56
	Utah	206	3.8	4.00	155.06
	Total	315	3.8	4.00	
An Oral Health Professional's Obligation to Society	Idaho	109	3.7	4.00	165.33
	Utah	207	3.6	4.00	154.90
	Total	316	3.6	4.00	
A Moral Obligation	Idaho	108	3.6	4.00	156.66
	Utah	205	3.6	4.00	157.18
	Total	313	3.6	4.00	
An Opportunity to Meet New People	Idaho	108	3.8	4.00	150.78
	Utah	206	3.9	4.00	161.02
	Total	314	3.9	4.00	
Increases Access to Oral Health Care	Idaho	109	4.5	5.00	154.91
	Utah	204	4.5	5.00	158.12
	Total	313	4.5	5.00	
An Opportunity to Enhance One's Resume	Idaho	109	3.8	4.00	149.85
	Utah	206	3.9	4.00	162.31
	Total	315	3.9	4.00	
A Meaningful Use of Discretionary Time	Idaho	108	3.6	4.00	148.81
	Utah	207	3.9	4.00	162.80
	Total	315	3.8	4.00	
A Requirement, Expectation or Option of Employers, Schools or Licensing Boards	Idaho	109	3.3	3.00	160.15
	Utah	207	3.2	3.00	157.63
	Total	316	3.2	3.00	

Volunteering	Mann Whitney-U Test	p
An Opportunity to Learn Something New	11009.500	0.812
An Opportunity to Earn Credit Hours to Satisfy Professional Licensing Requirements	10620.500	0.400
An Oral Health Professional's Obligation to Society	10537.000	0.311
A Moral Obligation	11033.000	0.959
An Opportunity to Meet New People	10398.500	0.302
Increases Access to Oral Health Care	10890.000	0.727
An Opportunity to Enhance One's Resume	10339.000	0.216
A Meaningful Use of Discretionary Time	10185.000	0.171
A Requirement, Expectation or Option of Employers, Schools or Licensing Boards	11101.500	0.806

were equal, the data was subjected to Levene's Test for Equality. In each instance, the resulting p value was greater than the critical value (0.05). Therefore, equal variances were assumed for all 3 GCOs subscales. The t statistic and degrees of freedom were also calculated for each subscale. Table IV shows there was no statistically significant difference in the average GCOS scores for Autonomy

Table IV: Motivational Orientations

GCOS	State Endorsement	n	Mean	Standard Deviation
Autonomy	Idaho	103	67.5	8.63516 9.34977
	Utah	200	66.2	
	Total	303		
Controlled	Idaho	103	46.7	8.62872 7.74241
	Utah	201	50.0	
	Total	304		
Impersonal	Idaho	103	37.1	9.50470 9.95291
	Utah	201	37.7	
	Total	304		
	Levene's Test for Equality of Variances		t-test for Equality of Means	
	F	p	t	df
Autonomy	0.852	0.357	1.190	301
Controlled	1.065	0.303	-3.348	302
Impersonal	0.348	0.556	-0.492	302
	Independent Samples t-test for Equality of Means			
	p		Mean Difference	Standard Error Difference
Autonomy	0.235		1.31544	1.10533
Controlled	0.001		-3.26687	0.97580
Impersonal	0.623		-0.58499	1.18800

and Impersonal subscale measures between dental hygienists endorsed by the states of interest. However, there was a statistically significant difference in the measure of Controlled Motivational Orientation. Dental hygienists licensed by the state of Utah scored higher on this dimension of motivation in comparison to dental hygienists licensed by the state of Idaho.

DISCUSSION

The study participants presented a demographic profile very much like the descriptions of dental hygiene populations in the literature.[21,35,39,40] Nonetheless, since this was a nonrandom sample survey data cannot be generalized beyond the target population. In addition to sampling error, this study was impacted by the bias of non-response error. The 11.5% response rate was below average. The failure of participants to be actively licensed to practice dental hygiene in Idaho or Utah and to provide responses in each section of the survey further reduced the size of the study sample. Despite these inherent research biases, 316 subjects provided valuable data to enhance understandings of volunteerism.[47-50] The results of this study were contrary to initial expectations of volunteer behaviors. Since dental hygienists licensed by the state of Idaho have the benefit of performing pro bono service in lieu of a portion of required continuing education hours, it

was assumed they would perform a comparatively higher number of service hours. However, the dental hygienists of Utah volunteered more often and many respondents from Idaho were unaware of volunteerism as a continuing education opportunity. .

Nearly half (45.2%) of both the Utah and Idaho dental hygienists surveyed, were uncertain if time spent volunteering professional services was an option for satisfying some of the continuing education hours required to renew the license to practice. This outcome suggests when dental hygienists are unaware or do not have a clear understanding of the details of state practice acts, amendments intended to encourage volunteerism may have little to no bearing on the actual number of volunteer hours performed.

Further explanation of the pattern of a nonsignificant difference, is that practitioners licensed by the state of Idaho simply might not perceive the substitution of volunteer hours for continuing education hours to be a meaningful or personally beneficial incentive. Some comparative research has shown altruistic inclinations to volunteer or internal feelings of civic responsibility can be suppressed in the presence of extrinsic incentives or the external regulation of prosocial behaviors.[21,23,25,43,51-53]

The lack of no significant differences in dental

hygienists' perceptions of volunteerism were also unexpected. Both Utah and Idaho dental hygienists rated the opportunity to earn credit hours to satisfy professional licensing requirements as an important reason to volunteer. Nevertheless, there was consensus that pro bono hours performed as a requirement, expectation or option to prove competency was neither an unimportant nor an important reason for volunteering.

Utah and Idaho dental hygienists strongly agreed volunteering was 'a reward in and of itself 'as well as a positive, personally meaningful and satisfying experience. The majority disagreed with dental hygienists being extrinsically rewarded or compensated in any way for volunteer efforts. Yet, when asked which factor would most likely encourage volunteerism, 44.1% of Utah and Idaho dental hygienists selected "credit hours to satisfy state licensing requirements." Only 29.6% chose the response option: "a sense of personal satisfaction."

While these inconsistencies could be attributed to biases in the research, they support the literary findings. Although individuals may report altruistic feelings or intrinsic factors are the impetus of prosocial intentions and behaviors, a willingness to volunteer may also be influenced by egoistical feelings activated by extrinsic forces.[26,42,51,52,54] SDT suggests a synergy between intrinsic and extrinsic factors must be encouraged if effective responsible human behavior is to be successfully stimulated.[30] According to the results of this study, while dental hygienists strongly identified with intrinsic factors as the motivations of prosocial behaviors and disapproved of rewarding or compensating dental hygienists for acts of volunteerism, respondents demonstrated support of external incentives.

The results of the GCOS portion of the survey instrument revealed the dominant Motivational Orientation among dental hygienists in both Utah and Idaho was Autonomy. This result suggests dental hygienists in the 2 states of interest respond to "aspects of the environment that simulate intrinsic motivation, tend to display greater self-initiation, seek activities that are interesting and challenging and take greater responsibility for his or her own behavior."[33] Therefore, simply increasing awareness of oral health needs and how practitioners can meet the needs, may be enough to encourage volunteerism in this population.

The only statistically significant difference between the 2 groups examined, were scores on the GCOS subscale of Controlled Motivational Orientation. Dental hygienists licensed by the state of Utah scored higher on this dimension of motivation when compared to dental hygienists licensed in Idaho. This result may reflect differences in supervision

requirements between the 2 states. In this exploration of volunteerism more than 60% of the survey respondents agreed or strongly agreed, practice act requirements for the direct or general supervision of professional functions were a deterrent to dental hygienists volunteering in a professional capacity. In addition to requirements for ongoing education and training, another dental practice act provision of particular consequence to the volunteering practices of dental hygienists are state directives related to practice supervision.[55,56] Utah is a state where dental hygienists practice under general supervision requirements.[57] Oral hygiene services are only permitted when patients have been examined and treatment is prescribed by a licensed dentist.[57] When encumbered by direct or general supervision requirements, dental hygienists must rely on the good will of dentists to support efforts to provide pro bono care. Direct and general supervision requirements may also create restrictions as to when, how and where dental hygienists provide community service.[6,11-16]

Alternatively, practice acts stipulating direct access are much more conducive to dental hygienists volunteering professional services.[55,56] Presently, over half of the states in the nation, including the state of Idaho, permit dental hygienists direct access to some degree.[55,56,58] Direct access provisions allow dental hygienists' to "initiate treatment based on his or her assessment of patient's needs without the specific authorization of a dentist, treat the patient without the presence of a dentist, and ... maintain a provider-patient relationship."[56]

According to SDT, general supervision constraints would frustrate a dental hygienist's need for autonomy.[28,32] Such practice provisions orient dental hygienists to external control of behaviors, which could intrude on intrinsic motivations to provide community service.[21,23,25,43,51-53] Because such practice provisions discourage rather than encourage self-determination, dental hygienists subject to this influence may feel there are fewer opportunities to volunteer. Ultimately practitioners may become less involved in volunteering in a professional capacity. Conversely, direct access regulations are social factors with the potential to increase dental hygienists' intrinsic motivations for volunteerism.

Conclusion

The lack of significant difference in the number of volunteer hours between licensed hygienists in Utah and Idaho should not be construed to mean legislation related to the substitution of pro bono hours for continuing education hours fails to affect the volunteer practices of dental hygienists. Additional research is required to make realistic determinations as to the effectiveness of such legislation. This investiga-

tion contributes to the body of knowledge regarding volunteerism in society and accentuates the need for additional explorations of the extent to which practice act regulations encourage or discourage dental hygienists' altruistic decisions and actions.

Legislators and members of professional licensing boards should consider dominant motivational orientations of dental hygienists as they compose and ratify policies intended to mobilize this population to provide charitable oral health assessments, care and education. To address the current oral health care crisis in this country, dental hygienists are in need of evidence based practice statutes and regulations that keep pace with the objective of universal access to comprehensive oral care.

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