



American
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Association

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- Fibromyalgia Syndrome: Considerations for Dental Hygienists
- Independent Analysis: Efficacy of Sealants Used in a Public Health Program
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- Knowledge and Behaviors Regarding Early Childhood Caries Among Low-Income Women in Florida: A Pilot Study

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The *Journal of Dental Hygiene* is the refereed, scientific publication of the American Dental Hygienists' Association. It promotes the publication of original research related to the profession, the education, and the practice of dental hygiene. The Journal supports the development and dissemination of a dental hygiene body of knowledge through scientific inquiry in basic, applied and clinical research.

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Features

- Review of the Literature** **76** **Fibromyalgia Syndrome: Considerations for Dental Hygienists**
Amber Walters, BSDH, MS; Susan L. Tolle, BSDH, MS; Gayle M. McCombs, BSDH, MS
- Short Report** **86** **Independent Analysis: Efficacy of Sealants Used in a Public Health Program**
Jodi L. Olmsted, RDH, PhD, FAADH; Nancy Rublee, RDH, CDHC; Laura Kleber, BS, CCRC; Emily Zurkawski, PTA
- Research** **91** **Barriers Faced by Expanded Practice Dental Hygienists in Oregon**
Amy E. Coplen, RDH, EPDH, MS; Kathryn P Bell, RDH, MS
- 101** **Exploring Preadmission Criteria as Predictors for Dental Hygiene Licensure Examinations Pass Rates**
Tammy R. Sanderson, RDH, MSDH; Marcia H. Lorentzen, RDH, MEd, EdD
- 109** **Assessment of Pathology Instruction in U.S. Dental Hygiene Educational Programs**
Barbara B. Jacobs, RDH, MS; Ann A. Lazar, PhD; Dorothy J. Rowe, RDH, MS, PhD
- 119** **The Relationship between Methamphetamine Use and Dental Caries and Missing Teeth**
E. Marcia Boyer, PhD; Nancy Thompson, PhD; Tracy Hill, RDH, BS, BA; M. Bridget Zimmerman, PhD
- 132** **Knowledge and Behaviors Regarding Early Childhood Caries Among Low-Income Women in Florida: A Pilot Study**
Maryam Rahbari, BA, RDH, MPH; Jaana Gold, DDS, PhD
- Editorial** **75** **Thank You for Your Support!**
Rebecca S. Wilder, RDH, BS, MS



Rebecca S. Wilder, RDH, BS, MS

Thank You for Your Support!

The Journal of Dental Hygiene continues to grow and expand thanks to the many individuals who submit their work to our publication and the numerous volunteers who provide their expertise to review these submissions. In addition, we have many individuals who are not formally on our Editorial Review Board who contribute their time when needed. This editorial is devoted to all of who continue to support the Journal of Dental Hygiene.

Our editorial review board is made up of a group of ultimate professionals from dental hygiene, dentistry, nursing, basic science, pathology, radiology and physical therapy. As our profession continues to expand and collaborate with other health care professionals, having a wide variation in expertise will be important. Thank you to all of the members who have contributed their knowledge and time to improving the writing skills of others and enhancing the quality of our publication.

The past year has continued to see changes. As you recall, in 2014 we increased from 4 to 6 issues per year. In late 2014 we transitioned to BenchPress, a web-based manuscript tracking and management service developed by HighWire Press for publishers of scholarly content. Now, we can provide improved service to our members. In addition, our peer reviewers can provide timely evaluations of the manuscripts which will equate to quicker communication with authors. We applaud the ADHA staff and ADHA Board for their support of this system, to improve the service to our members.

I wish to gratefully acknowledge the support and valuable contributions of the American Dental Hygienists' Association for their commitment to the Journal of Dental Hygiene and for recognizing the value of scholarship to the growth of the profession. Specifically, I wish to thank our Journal Staff Editor, Josh Snyder, for his attention to detail, professional manner, patience with authors, review board members and me! Also, a special thank you to Ann Battrell, Executive Director of the ADHA, for her support of the Communications Divisions and her leadership at the ADHA. And, since last summer, we have a new Director of Communications who oversees the division that houses the Journal of Dental Hygiene. John Iwanski has been very supportive of the Journal and he also brings much expertise from his previous positions at other associations who publish scientific publications.

Finally, I would like to acknowledge the passing of one of our cherished editorial review board members, Professor Michele Darby. Michele served as editor of the Journal of Dental Hygiene many years ago and she was an active reviewer most of her career. I will personally miss Michele's enthusiasm for new research and scholarly ideas.

Thanks again and I look forward to working with each of you to continually improve our Journal!

Sincerely,

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

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Review of the Literature

Fibromyalgia Syndrome: Considerations for Dental Hygienists

Amber Walters, BSDH, MS; Susan L. Tolle, BSDH, MS; Gayle M. McCombs, BSDH, MS

Introduction

Fibromyalgia syndrome (FMS) is a neurosensory disorder of unknown etiology characterized by chronic musculoskeletal pain, fatigue, tenderness and sleep disturbances. FMS can result in severe disability and loss of function, leading to decreased quality of life.¹ This disorder can affect any aspect of an individual's body, including the oral cavity, and adverse orofacial conditions are common. Modifications in dental hygiene treatment are often needed to ensure patient comfort and optimum treatment. In addition, oral care practitioners may identify early symptoms of FMS, assisting the patient in receiving a proper diagnosis. Appropriate dental hygiene management requires an understanding of disease characteristics and pathophysiology, oral health considerations and treatment interventions.

Epidemiology

FMS is the second most common diagnosis made by rheumatologists and is estimated to affect 3 to 6% of the population worldwide.^{2,3} FMS can affect anyone regardless of age, gender or ethnicity; however 75 to 90% of people diagnosed are women.³ Prevalence of fibromyalgia is higher at middle age (30 to 50 years) or over the age of 50.⁴⁻¹³ The worldwide incidence of FMS is 6.88 per 1,000 males and 11.28 per 1,000 females.¹⁴ The incidence may be increasing and is linked to increased disease awareness among physicians.

Basic Characteristics

The 1990 American College of Rheumatology classification criteria for FMS included a history of chronic, diffuse pain affecting 4 quadrants of the body for at least 3 months and pain upon palpation in at least 11 out of 18 tender points.¹⁵ In 2010, the American College of Rheumatology revised this criterion, eliminating the need to assess ten-

Abstract

Purpose: Fibromyalgia syndrome (FMS) is a neurosensory disorder characterized by widespread musculoskeletal pain. Typically persistent fatigue, depression, limb stiffness, non-refreshing sleep and cognitive deficiencies are also experienced. Oral symptoms and pain are common, requiring adaptations in patient management strategies and treatment interventions. Appropriate dental hygiene care of patients suffering with this disorder is contingent upon an understanding of disease epidemiology, pathophysiology, clinical characteristics, oral signs and symptoms, as well as treatment approaches. With this information dental hygienists will be better prepared to provide appropriate and effective treatment to patients with FMS.

Keywords: fibromyalgia, oral hygiene, orofacial pain, special needs, medically complex patients

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

der points. Instead, the criteria requires a detailed interview to evaluate total body pain using a Widespread Pain Index, as well as a measurement of symptom severity, known as the Symptom Severity scale.¹⁶ To be diagnosed with FMS the criteria found in Figure 1 must be met.

The most predominant symptom of FMS is chronic, widespread musculoskeletal pain, described as being persistent, deep, aching and/or throbbing. Hyperalgesia (exaggerated or prolonged response to stimuli), dysesthesia (unpleasant, abnormal sense of touch) and allodynia (perception of pain to a non-painful stimulus) are also common findings.^{17,18} Some people experience uniform pain all day long, while others report pain that is worse in the morning, improves during the day and worsens again at night. Pain associated with FMS can be exacerbated by physical or emotional stress, non-restorative sleep, strenuous activity and changes in weather.^{18,19}

Fatigue, cognitive deficiency, tenderness upon mild palpation and non-restorative sleep are common manifestations often accompanied by a wide array of additional symptoms listed in Figure 2.^{20,21}

The onset of symptoms can appear suddenly; however, they are generally experienced gradually.^{20,22} Common psychiatric and medical comorbidities may also be present (Figure 3).^{18,21}

Diseases of fatigue and widespread pain have similar signs and symptoms making the diagnosis of FMS difficult. Lyme disease, hypothyroidism, rheumatoid arthritis, systemic lupus and undiagnosed cancer are often confused with FMS (Figure 4).^{18,22} Because there are no objective laboratory or radiographic tests to definitively diagnose FMS, patients often report a long delay between onset of symptoms and a diagnosis.¹

Sleep disturbances reported include non-restorative sleep, insomnia and poor quality of sleep.²³ Munguia-Izquierdo and Legaz-Arrese revealed the prevalence of poor sleep quality was 96% in patients with FMS compared to 46% for healthy subjects.²⁴ Quality of sleep was much lower in patients with FMS compared to controls and poor sleep quality was strongly associated with pain and fatigue.²⁴

FMS can result in severe disability and loss of function, making daily tasks, including oral self-care, difficult or unmanageable.^{1,19,25} Research by Bennett et al suggests people with FMS have difficulty with routine activities such as walking 2 blocks (55%), climbing stairs (62%), shopping (66%), household chores (68%) and carrying 10 pounds (70%).¹⁹ The debilitating effects of FMS can also be seen in the work place. Decreased ability to function leads to loss in productivity, increased work absenteeism and an overall decreased quality of life.²⁶ In fact, working adults with FMS miss an average of almost 17 days of work annually compared to 6 days for those without the syndrome.²⁷ Fatigue, inability to concentrate, decreased motivation, and low self-efficacy may contribute to poor job performance.

Depression, anxiety, stress and impaired cognitive function are common psychological findings in patients with FMS. Bennett et al found 38% of FMS patients reported anxiety and 40% reported depression.¹⁹ These psychological disturbances may be related to coping with the debilitating effects and chronic pain of FMS, rather than a primary symptom.²⁸ Cognitive deficiency in people with FMS is sometimes called "fibro fog" and includes short-term memory loss, reduced mental alertness and decreased ability to multitask.^{18,21}

Pathophysiology

FMS is linked to a multifactorial etiology.²² Sus-

Figure 1: 2010 Fibromyalgia Syndrome Diagnostic Criteria¹⁶

Criteria:
A patient meets the diagnostic criteria for FMS if these 3 conditions are met: <ul style="list-style-type: none"> • Widespread pain index ≥ 7 and symptom severity scale score ≥ 5 or Widespread Pain Index 3 to 6 and Symptom Severity scale score ≥ 9 • The patient has been experiencing symptoms at a similar level for 3 months or longer • The patient does not have any other condition that would explain the pain
Scoring:
Widespread Pain Index: Count the number of regions the patient reports pain within the last week <ul style="list-style-type: none"> • Score will range 0 to 19. Symptom Severity Scale Score*: Indicate how severe each of these 3 symptoms (fatigue, waking unrefreshed, cognitive symptoms) have been over the past week using the following scale: <ul style="list-style-type: none"> • 0 - No problem • 1 - Slight or mild problems • 2 - Moderate, often present and/or at a moderate level • 3 - Severe, continuous, life-disturbing problems Considering common other symptoms, note whether the patient has: <ul style="list-style-type: none"> • 0 - no symptoms • 1 - few symptoms • 2 - a moderate amount of symptoms • 3 - many symptoms

*The Symptom Severity scale score is the sum of the severity of the 3 symptoms (fatigue, waking unrefreshed, cognitive symptoms) and the extent of the other symptoms in general. Score will be between 0 and 12.

Figure 2: Symptoms of Fibromyalgia Syndrome¹⁶

Muscle pain	Blurred vision
Irritable bowel syndrome	Fever
Tiredness	Diarrhea
Thinking or memory problems	Tinnitus
Muscle weakness	Vomiting
Migraines	Seizures
Numbness or tingling	Dry eyes
Stiffness	Loss of appetite
Trouble sleeping	Rash
Depression	Sensitivity to light
Nausea	Hearing difficulties
Frequent or painful urination	

Figure 3: Comorbidities of Fibromyalgia Syndrome^{18,21}

Anxiety	Myofascial pain syndrome
Chronic fatigue syndrome	Raynaud's phenomenon
Depression	Restless leg syndrome
Interstitial cystitis	Sjögren's syndrome
Irritable bowel syndrome	Temporomandibular joint disorder (TMD)

Figure 4: Differential Diagnoses for Fibromyalgia Syndrome^{18,22}

Adrenal dysfunction	Myofascial pain
Anemia	Psychiatric conditions
Bone marrow disease	Rheumatoid arthritis
Chronic fatigue syndrome	Sleep disorders
Human immunodeficiency virus (HIV)	Systemic inflammation or infection
Hypothyroidism	Systemic lupus erythematosus
Lyme disease	Viral hepatitis
Multiple sclerosis	Vitamin and/or mineral deficiency

pected causes of FMS include abnormalities in pain pathways, as well as genetic and environmental factors.²¹⁻²³ Cerebrospinal fluid substance P is a neurotransmitter released when axons are stimulated. Consistently elevated in people with FMS, this causes increased sensitivity and enhanced awareness of pain.^{23,29} Substance P helps regulate the responsiveness of N-methyl-D-aspartate receptors to the neurotransmitter glutamate, which plays a role in central sensitization and temporal summation.^{20,21} Concentration of substance P in cerebrospinal fluid is 2 to 3 times higher in people with FMS compared to control subjects.^{23,29} Substance P is involved in transmission of pain information from the periphery to the central nervous system (CNS). Research suggests the combined effect of low serotonin levels and high substance P concentration, contribute to more pain than either abnormality on their own, and this dual dysfunction may be responsible for the onset of FMS.^{21,30}

The CNS is the predominant source of pain in FMS. CNS sensitization, increased excitability of neurons found in the spinal cord, makes neurons more sensitive to stimuli. Central sensitization is characterized by an exaggerated pain response, prolonged duration of pain, increased pain intensity and wider pain distribution.²¹ A related phenomenon to sensitization is temporal summation, called "wind-up," which occurs when a stimuli is applied repeatedly. With each repeated stimulation there is a progressive increase in pain leading to prolonged stimulation of C nerve fibers.²¹ Research suggests levels of temporal summation from repetitive stimulation in people with FMS consistently exceed those of control subjects over a range of stimulus frequencies.^{31,32} These phenomenon most likely result in people with FMS exhibiting a lower threshold of pain in response to stimuli.

the abnormal functioning of the hypothalamic-pituitary-adrenal axis is linked to sleep disturbances in patients with FMS.^{21,22} In response to stress, the body secretes cortisol, and during chronic stress the body continually increases secretion of this chemical. In an effort to counteract the elevated amount of cortisol, the negative feedback loop is amplified which eventually leads to overcompensation and cortisol deficiency.²² This cortisol deficiency is most likely culpable in causing non-restorative sleep for FMS patients.²²

Research has also linked abnormal levels of the neurotransmitters serotonin, norepinephrine and dopamine with FMS.^{2,20,22,23,30,33} Low serotonin levels are the most widely acknowledged biochemical irregularity found in people with FMS and are of particular interest due to their affect on delta sleep and pain modulation.^{18,22,23,33-35} Serotonin and norepinephrine play a role in stopping pain response by hindering pain pathways. When individuals with FMS have decreased levels of these neurotransmitters their pain is prolonged.^{20,22} Dopamine plays a critical role in modulating pain perception in the CNS by inhibiting pain pathways and inducing natural analgesia during acute stress. During chronic stress the body tries to restore homeostasis and dopamine eventually becomes decreased due to overcompensation of the negative feedback loop, leading to a hyperalgesic state.

Both genetic and environmental factors may be involved in the development of FMS. Research suggests the high occurrence of FMS in families may be attributed to genetic factors.³⁶⁻³⁸ Women who have a relative with FMS are more likely to have the syndrome; however, it is unclear whether this is due to genetics, shared environmental factors or both.³⁹

A neuroendocrine system dysfunction involving

Environmental triggers such as mechanical or

physical trauma and psychosocial factors have been correlated with the development of FMS.³³ A study by Bennett et al suggests chronic stress is the most perceived triggering event of FMS onset (41%) followed by emotional trauma (31.3%).¹⁹ Trauma and stress may alter the pain modulatory response in the brain, which could contribute to the enhanced pain perception. Acute illness, serious infection, physical injury, surgery, motor vehicle accidents and other pain conditions are also commonly reported physical stressors.^{19,33} Psychosocial factors, such as a catastrophic event or abuse (emotional, physical or sexual) have also been associated with onset of symptoms.^{19,33} However, research on the relationship between physical and emotional abuse and the diagnosis of FMS have been inconsistent.^{40,41} Havilan et al revealed a correlation between both sexual assault/abuse and physical assault/abuse and FMS diagnosis; however, life-threatening trauma, emotional abuse/neglect and major life stress were not found to be associated with FMS diagnosis.⁴²

Treatment

Treatment of FMS focuses on symptom management and improving quality of life. A holistic approach that integrates physical, psychological and behavioral factors with the implementation of pharmacological and non-pharmacological strategies is helpful in managing FMS.^{1-3,18-21,33,35} Medications approved by the Food and Drug Administration for the treatment of FMS include pregabalin (Lyrica®; Pfizer, New York, NY), duloxetine (Cymbalta®; Eli Lilly and Company, Indianapolis, Ind.), and milnacipran (Savella®; Forest Laboratories, New York, NY).^{1,3,21} Non-pharmacological therapies for treatment of FMS include patient education, exercise, and cognitive behavioral therapy. Additionally, acupuncture, hypnotherapy, balneotherapy (medicinal baths), biofeedback, ultrasound, relaxation therapy and tender point injections have been reported as treatment options; however, evidence is lacking to support the effectiveness of these therapies.^{18,33}

Oral Concerns

Most patients with FMS report symptoms of facial pain, including discomfort in the muscles of mastication, temporomandibular joint (TMJ), neck, ear and jaw.⁴³ A study by Alonso-Blanco et al investigated the differences in prevalence and localization of referred pain areas of active trigger points between 20 women with myofascial temporomandibular joint dysfunction (TMD) and 20 women with FMS. Results revealed participants with FMS had larger referred pain areas than those with TMD

for the sternocleidomastoid and suboccipital muscles.⁴⁴ Leblebici et al sought to determine the correlation between FMS, TMD and masticatory myofascial pain. A group of 31 people diagnosed with FMS and a group of 21 people diagnosed with TMD completed a questionnaire and underwent a clinical examination, which included bilateral manual palpation of the masticatory muscles. The questionnaire consisted of questions about prior head and neck trauma, parafunctional habits, muscle fatigue, crepitus of the TMJ, restricted mandibular movement, jaw pain and prior TMD treatment. Results revealed 80% of patients with FMS had masticatory myofascial pain and TMD.⁴⁵ This data supports previous research that indicated the high rate of involvement of the stomatognathic system in the course of FMS.⁴⁶ Myofascial pain in fibromyalgic persons has also been noted in several other studies, ranging from 40.9 to 85%.^{43,47,48} A study by Pimentel et al revealed facial muscle pain has been reported to be 31-times more prevalent in people with FMS than those without the syndrome.⁴³ Additionally, in a study conducted by Fraga et al, masticatory muscle pain was reported by 93.3% of people with FMS in at least one masticatory muscle.⁴⁷ A study by Wolfe et al revealed jaw pain specifically was self-reported by 35.4% of individuals with FMS.⁴⁹

Many patients with FMS also experience symptoms of TMD. A study by Pimentel et al investigated the prevalence of clinical features of TMD in people with FMS. Forty women with FMS were compared to 40 healthy controls using the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD). Results indicated 77.5% of the subjects with FMS met the diagnostic criteria for RDC/TMD Group I (muscle involvement) compared to 10% of the control group.⁴³ Previous studies have also shown fibromyalgic persons have a high prevalence of signs and symptoms of TMD, ranging from 67.6 to 93.4%.^{45-48,50-52} Additionally, studies suggest FMS may be a predisposing factor for the onset of TMD,^{43,47,48,53,54} especially considering there are more individuals with FMS who have TMD than people with TMD who have FMS.^{45,46}

Routine treatments of TMD may not benefit people with FMS because the comorbidity of these 2 conditions may result from the alteration in pain perception. Failure of the dental hygienist to acknowledge the underlying FMS diagnosis may lead to lack of appropriate treatment. Occlusal splints often recommended for patients suffering from TMD, have not been shown to be beneficial for treating myofascial pain in people with widespread pain.⁵⁵ However, tactile stimulation in the form of massage has had a positive effect on clinical signs

and subjective symptoms of TMD, as well as widespread pain in FMS patients who were unaffected by routine TMD treatment.⁵⁶

Additional oral manifestations prevalent in FMS patients include limited mouth opening, pain upon opening and masticatory pain.^{43,50} Muscle and joint pain during opening and closing is prevalent with FMS.⁴³ The prevalence of limited mouth opening has been reported to be 10 times higher in people with FMS than controls with the average maximum voluntary mouth opening for FMS patients at 41 mm, compared to 44 mm in the control group.⁴³ The exact cause is unknown, but it is likely muscle pain during jaw movements contributes to lower range of motion during mouth opening.

Xerostomia is another common oral manifestation associated with FMS. Medications such as antidepressants, hypnotics, muscle relaxants, analgesics and anticonvulsants used to treat FMS may contribute to xerostomia.¹⁷ A study by Rhodus et al investigated the prevalence of oral symptoms in patients diagnosed with FMS. Sixty-seven women with FMS and matched controls completed a questionnaire and underwent an oral examination. The questionnaire included questions about subjective symptoms of glossodynia (oral burning), xerostomia, dysphagia (difficulty swallowing), taste abnormalities and TMD. Results revealed approximately 70% of subjects with FMS experienced xerostomia.⁵¹ Only 27.5% of FMS subjects who experienced xerostomia were taking xerogenic medications, therefore research suggests a high prevalence of xerostomia in this patient population even when controlling for xerostomia-inducing medications.⁵¹ FMS patients may experience increased caries rate, periodontal disease, dysphagia, dysgeusia (distortion of taste), mouth ulcers and candidiasis due to xerostomia.¹⁷

Glossodynia is commonly accompanied by xerostomia and dysgeusia and is experienced by approximately one-third of fibromyalgic persons.⁵¹ Glossodynia may represent hyperalgesia and allodynia resulting from nervous system sensitization.⁵¹ The neurological mechanisms responsible for glossodynia may also contribute to chronic pain in FMS. Treatment of glossodynia can be difficult due its unknown etiology. Glossodynia is a side effect of certain medications; however, it may also be caused by nutritional deficiencies, hormonal imbalances or depression.⁵⁷ Tricyclic antidepressants may benefit people with FMS and glossodynia because they can be used to treat depression, which may play a role in the development of oral burning and manage chronic pain.^{2,17,33,57}

Figure 5: Orofacial Manifestations of Fibromyalgia Syndrome^{17,50}

Xerostomia	Dysgeusia
Glossodynia	Dysphagia
Temporomandibular joint disorder (TMD)	
Pain or fatigue in the orofacial region	

Dysgeusia is also experienced by FMS patients.⁵¹ It is unclear whether dysgeusia represents a true oral manifestation of FMS or is a side effect of medications. Xerostomia can induce dysgeusia because normal salivary flow and concentration are essential for taste. If dysgeusia is drug-induced, patients can consult their physician about substituting another medication in place of the one causing taste disturbances.⁵⁸

Patient Management

A detailed history of FMS should be documented including date of diagnosis, course of the syndrome and all current medications. Patients should be questioned about orofacial pain and headaches that may be indicative of TMD, as well as possible oral manifestations of FMS including xerostomia, glossodynia and dysgeusia (Figure 5). When performing an extraoral exam, the dental hygienist should be cognizant of possible patient discomfort in the regions of the TMJ and muscles of mastication. Additionally, if FMS is not diagnosed and suspected, the dental hygienist should refer the patient for further medical evaluation.¹⁷

Dental hygienists should consider adaptations during the process of care to ensure patient comfort and an efficacious appointment. Patients should be queried about what time of day they feel best and scheduled accordingly. Many FMS patients experience pain and stiffness that is more severe in the morning; therefore, a late morning or early afternoon appointment may work best. However, patients with FMS may cancel at the last minute complaining of pain, fatigue or lack of restful sleep. Additionally, FMS patients may not be able to tolerate long appointments due to jaw tiredness and pain. If possible, offer to break up the patient's treatment plan to accommodate shorter appointments. To promote efficiency during the appointment, a dental hygiene assistant and 4-handed dentistry is recommended. Patients should also be asked to complete medical history forms prior to arrival. To conserve energy and help prevent post exertional malaise following the appointment, a disabled parking space should be available and FMS patients should be treated in an operatory close to the reception area.

A stress-free treatment environment is ideal since stress can exacerbate the pain response in FMS patients.^{18,19} Strategies to help manage stress during the appointment include developing a trusting relationship between the patient and the practitioner, effective pain management strategies, and, for some patients, nitrous oxide-oxygen sedation. Muscle relaxants may also assist patients with keeping the mouth open wider and more comfortably for a longer period of time also reducing stress. Moreover, FMS patients may find breathing or relaxation exercises helpful prior to and during the dental hygiene appointment to reduce stress.

Preventing oral infection is important since infection increases stress on the body, which consequently exacerbates symptoms of FMS.^{19,50} Frequent recare appointments should be encouraged to help prevent oral infection and monitor oral self-care. Caution should be used when prescribing antibiotics, as they may increase therapeutic levels of other medications FMS patients may be taking such as citalopram (Celexa®; Forest Laboratories, New York, NY) and zopiclone (Imovane®; Sanofi-Aventis, Bridgewater, NJ).¹⁷ Some FMS patients may benefit by taking anti-anxiety medication or muscle relaxant prior to their dental hygiene appointment to help reduce emotional stress or anxiety. Since FMS patients often experience heightened pain sensitivity and fatigue, modifications may be necessary to ensure patient comfort and adequate pain management. Both topical and local anesthetic agents are recommended to manage discomfort during scaling and root debridement. Anesthetic agents with vasoconstrictors should be avoided for patients taking amitriptyline (Elavil®, AstraZeneca, London, UK), venlafaxine (Effexor®, Wyeth Pharmaceuticals, Madison, NJ) or duloxetine because they may create a hypertensive crisis.¹⁷ Some patients may require intravenous sedation for more extensive treatment. Prolonged periods of jaw opening should be avoided and frequent breaks may be necessary for jaw rest. During dental hygiene care, practitioners will find a mouth prop or bite block most effective as this can provide additional support for those who have limited mouth opening or fatigue easily.

Because jaw pain may persist after the dental hygiene appointment, FMS patients should be encouraged to eat a soft diet, use warm compresses in the jaw region (unless heat exacerbates their symptoms) and use analgesics such as tramadol (Ultram®; Janssen Pharmaceutics, Titusville, NJ) or muscle relaxants such as cyclobenzaprine (Flexiril®; McNeil Consumer and Specialty Pharmaceuticals, Fort Washington, Penn) and tizanidine (Zanaflex®; Acorda Therapeutics, Ardsley, NY).¹⁷

NSAIDs (e.g., aspirin and ibuprofen) should not be recommended for patients taking selective serotonin reuptake inhibitors because they may increase the risk of prolonged bleeding.¹⁷

Patients with FMS are often hypersensitive to stimuli such as noise, heat, cold, touch and light.^{1,21,23} These normally non-painful stimuli may produce pain for people with FMS. Therefore, patients should be consulted about the impact of extraneous noise, such as background music, televisions and powered scalers so these can be eliminated or minimized if bothersome. A blanket or warm neck roll should be readily available if the patient gets cold. A cervical pillow can be used to support the neck better than the conventional dental chair headrest and reduce pressure on tender points located on the back of the head and neck. Additionally, since some FMS patients experience hypersensitivity to light, oral care professionals should be conscientious of not shining the dental light in the patient's eyes and tinted eyewear should be provided.

Patient Education

In order to reduce stress and improve FMS symptoms, oral care professionals should encourage their patients to live a healthy lifestyle. Poor nutrition can increase the production and secretion of stress hormones and decrease the secretion of insulin, which can lead to a lowered resistance to infection such as periodontal disease.⁵⁷ Dietary counseling can be utilized when appropriate to promote healthy eating habits. Data suggests tobacco smoking may exacerbate clinical features of FMS patients.^{59,60} As part of encouraging a healthy lifestyle, tobacco cessation should be recommended.

Due to the debilitating effects of FMS and comorbidities, patients may have difficulty performing oral self-care. Extremities of FMS patients often feel swollen, with upper extremities more impacted than lower extremities; therefore, oral self-care may be negatively affected.⁶¹ Additionally, FMS often co-occurs (up to 25 to 65%) with other rheumatic conditions, and as a result of these conditions, some patients may experience dexterity issues.⁶² FMS patients with impaired manual dexterity may find powered toothbrushes, flossing devices and interdental brushes helpful.⁶² However, the noise from a powered device may be a problem for FMS patients with heightened sensitivity to sound. Another option is the Surround® toothbrush, which can be recommended if finances or noise prevent the purchase or use of powered devices or the patient fatigues easily.⁶³ For some patients, modifying the toothbrush by extend-

ing or enlarging the handle may also be helpful.⁶³ These modifications can also be performed on floss handles and interdental brushes.

Depression is another common finding with FMS patients that may have a negative effect on oral health due to lack of self-care. Dental hygienists should be compassionate and provide encouragement to FMS patients realizing self-care may not always be a priority or may be difficult to accomplish. Clinicians must be cognizant of the psychological toll FMS takes on many individuals, as well as its overall debilitating effects. Due to the high prevalence of cognitive issues resulting in decreased mental alertness and memory (fibro fog), patients may benefit from written self-care instructions and educational materials they can take home to reinforce important concepts.

Patients should be educated on the difference between the chronic, widespread FMS pain and acute pain from an oral disease or infection. Patients may attribute dental pain to symptoms of FMS and not seek immediate care, resulting in minor dental disease escalating to major. Therefore, frequent recare intervals are critical to ascertain oral disease status on a regular basis. Additionally, with frequent recare, dental needs may be identified early, and be provided before more extensive treatment is required, which may be difficult for the patient to withstand.

Dental hygienists should encourage FMS patients with xerostomia to take an active role in the management of their symptoms to minimize risk of adverse oral effects. Strategies to help alleviate xerostomia include using saliva substitutes and sialogogues, and avoiding alcohol and caffeine consumption. Saliva substitutes can be used to replace moisture and lubricate the mouth for short term relief. Sialogogues are any agent, over-

the-counter or prescription, that aid in more long term relief by stimulating new saliva. Prescription sialogogues such as pilocarpine (Salagen®; Eisai, Woodcliff Lake, NJ) and cevimeline (Evovac®; Daiichi Sankyo, Parsippany, NJ) can be recommended for patients who do not have medication-induced xerostomia. Chewing sugar free gum with xylitol is also typically recommended for patients with xerostomia to stimulate salivary flow; however, many FMS patients experience pain upon mastication and therefore this management strategy would be contraindicated. Xylitol mints and lozenges could be suggested as they provide both caries benefit and improve salivary flow without stressing masticatory muscles.

Conclusion

FMS is a common disorder that encompasses symptoms of chronic, widespread musculoskeletal pain, fatigue, cognitive deficiency and sleep disturbances. Oral manifestations of FMS are common and affect the oral and overall health of the patient. Dental hygienists must be knowledgeable about oral signs and symptoms of FMS in order to educate their FMS patients on management strategies and oral self-care modifications. Additionally, dental hygienists should be prepared to make appropriate adjustments when treating patients with FMS to ensure hygiene care is rendered in a comfortable and effective manner.

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References

1. Paxton S. Perioperative care of the patient with fibromyalgia. *AORN J*. 2011;93(3):380-386.
2. Morin AK. Fibromyalgia: a review of management options. *Formulary*. 2009 Dec;44:362-373.
3. National Fibromyalgia and Chronic Pain Association. Fibromyalgia [Internet]. 2013 [cited 2013 Sep 9]. Available from: <http://www.fmcpaware.org>
4. Senna E, De Barros A, Silva E, et al. Prevalence of rheumatic diseases in Brazil: a study using the COPCORD approach. *J Rheumatol*. 2004;31(3):594-597.
5. Mas AJ, Carmona L, Valverde M, Ribas B. Prevalence and impact of fibromyalgia on function and quality of life in individuals from the general population: results from a nationwide study in Spain. *Clin Exp Rheumatol*. 2008;26(4):519-526.
6. Topbas M, Cakirbay H, Gulec H, et al. The prevalence of fibromyalgia in women aged 20-64 in Turkey. *Scand J Rheumatol*. 2005;34(2):140-144.
7. Cobankara V, Unal U, Kaya A, et al. The prevalence of fibromyalgia among textile workers in the city of Denizli in Turkey. *Int J Rheum Dis*. 2011;14(4): 390-394.
8. McNally J, Matheson D, Bakowsky V. The epidemiology of self-reported fibromyalgia in Canada. *Chronic Dis Can*. 2006;27(1):9-16.
9. Ablin J, Oren A, Cohen S, et al. Prevalence of fibromyalgia in the Israeli population: a population-based study to estimate the prevalence of fibromyalgia in the Israeli population using the London Fibromyalgia Epidemiology Study Screening Questionnaire (LFESSQ). *Clin Exp Rheumatol*. 2012;30:39-43.
10. Branco J, Bannwarth B, Failde I, et al. Prevalence of fibromyalgia: a survey in five European countries. *Semin Arthritis Rheum*. 2010;39(6):448-453.
11. Wolfe F, Brähler E, Hinz A, Häuser W. Fibromyalgia prevalence, somatic symptom reporting, and the dimensionality of polysymptomatic distress: results from a survey of the general population. *Arthritis Care Res*. 2013;65(5):777-785.
12. Lindell L, Bergman S, Petersson I, et al. Prevalence of fibromyalgia and chronic widespread pain. *Scand J Prim Health Care*. 2000;18(3):149-153.
13. Turhanoglu A, Yilmaz S, Kaya S, et al. The epidemiological aspects of fibromyalgia syndrome in adults living in turkey: a population based study. *J Musculoskelet Pain*. 2008;16(3):141-147.
14. Weir PT, Harlan GA, Nkoy FL, et al. The incidence of fibromyalgia and its associated comorbidities: a population-based retrospective cohort study based on International Classification of Diseases, 9th Revision codes. *J Clin Rheumatol*. 2006;12(3):124-128.
15. Wolfe F, Smythe HA, Yanus MB, et al. The American College of Rheumatology 1990 criteria for the classification of fibromyalgia. *Arthritis Rheum*. 1990;33(2):160-172.
16. Wolfe F, Clauw D, Fitzcharles MA, et al. The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. *Arthritis Care Res*. 2010;62(5):600-610.
17. Balasubramaniam R, Laudenbach JM, Stoopler ET. Fibromyalgia: an update for oral health providers. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2007;104(5):589-602.
18. Huynh CN, Yanni LM, Morgan LA. Fibromyalgia: diagnosis and management for the primary healthcare provider. *J Womens Health*. 2008;17(8):1379-1387.
19. Bennett RM, Jones J, Turk DC, Russell IJ, Mattallana L. An internet survey of 2,596 people with fibromyalgia. *BMC Musculoskelet Disord*. 2007;8:27.
20. Longley K. Fibromyalgia: aetiology, diagnosis, symptoms and management. *Br J Nurs*. 2006;15(13):729-733.
21. Dhar M. Pathophysiology and clinical spectrum of fibromyalgia: a brief overview for medical communicators. *AMWA Journal*. 2011;26(2):50-54.
22. Weirwille L. Fibromyalgia: diagnosing and managing a complex syndrome. *J Am Acad Nurse Pract*. 2012;24(4):184-192.

23. Bradley LA. Pathophysiology of fibromyalgia. *Am J Med.* 2009;122:(12 Suppl): S22-30.
24. Munguía-Izquierdo D, Legaz-Arrese A. Determinants of sleep quality in middle-aged women with fibromyalgia syndrome. *J Sleep Res.* 2012;21(1):73-79.
25. Martinez GG, Kravitz L. Exploring fibromyalgia: the puzzling pain-fatigue syndrome. *IDEA Fitness Journal.* 2013;10(4):26-34.
26. McDonald M, DiBonaventura M, Ullman S. Musculoskeletal pain in the workforce: the effects of back, arthritis, and fibromyalgia pain on quality of life and work productivity. *J Occup Environ Med.* 2011;53(7):765-770.
27. Kleinman N, Harnett J, Melkonian A, et al. Burden of fibromyalgia and comparisons with osteoarthritis in the workforce. *J Occup Environ Med.* 2009;51(12):1384-1393.
28. Arslan S, Yunus MB. Fibromyalgia: making a firm diagnosis, understanding its pathophysiology. *Consultant.* 2003;43(10):1233-1244.
29. Russell IJ, Orr MD, Littman B, et al. Elevated cerebrospinal fluid levels of substance P in patients with the fibromyalgia syndrome. *Arthritis Rheum.* 1994;37(11):1593-1601.
30. Iqbal R, Mughal MS, Arshad N, Arshad M. Pathophysiology and antioxidant status of patients with fibromyalgia. *Rheumatol Int.* 2011;31(2):149-152.
31. Staud R, Vierck CJ, Cannon RL, et al. Abnormal sensitization and temporal summation of second pain (wind-up) in patients with fibromyalgia syndrome. *Pain.* 2001;91(1-2):165-175.
32. Staud R, Cannon RC, Mauderli AP, et al. Temporal summation of pain from mechanical stimulation of muscle tissue in normal controls and subjects with fibromyalgia syndrome. *Pain.* 2003;102:87-95.
33. Peterson EL. Fibromyalgia: management of a misunderstood disorder. *J Am Acad Nurse Pract.* 2007;19(7):341-348.
34. Boomershine CS. Fibromyalgia [Internet]. 1994-2014 [cited 2013 Oct 26]. Available from: <http://emedicine.medscape.com/article/329838-overview>
35. Perrot S, Dickenson AH, Bennett RM. Fibromyalgia: harmonizing science with clinical practice considerations. *Pain Pract.* 2008;8(3):177-189.
36. Arnold L, Hudson J, Hess E, et al. Family study of fibromyalgia. *Arthritis Rheum.* 2004;50(3):944-952.
37. Hudson J, Arnold L, Keck P, et al. Family study of fibromyalgia and affective spectrum disorder. *Biol Psychiatry.* 2004;56(11):884-891.
38. Bradley L, Fillingim R, Sotolongo A, et al. Familial aggregation of pain sensitivity in fibromyalgia. *J Pain.* 2006;7(4):S1.
39. National Institute of Arthritis and Musculoskeletal and Skin Diseases. Questions and answers about fibromyalgia [Internet]. 2012 [cited 2013 Sep 9]. Available from: http://www.niams.nih.gov/Health_Info/Fibromyalgia/default.asp
40. Romans S, Cohen M. Unexplained and underpowered: the relationship between psychosomatic disorders and interpersonal abuse: a critical review. *Harv Rev Psychiatry.* 2008;16(1):35-54.
41. Russell IJ, Raphael KG. Fibromyalgia syndrome: presentation, diagnosis, differential diagnosis, and vulnerability. *CNS Spectr.* 2008;13(3 Suppl):6-11.
42. Havilan MG, Morton KR, Oda K, Fraser GE. Traumatic experiences, major life stressors, and self-reporting a physician-given fibromyalgia diagnosis. *Psychiatry Res.* 2010;177(3): 335-341.
43. Pimentel MJ, Gui MS, de Aquino LM, Rizzatti-Barbosa CM. Features of temporomandibular disorders in fibromyalgia syndrome. *Cranio.* 2013;31(1):40-45.
44. Alonso-Blanco C, Fernández-de-Las-Peñas C, de-la-Llave-Rincón AI, et al. Characteristics of referred muscle pain to the head from active trigger points in women with myofascial temporomandibular pain and fibromyalgia syndrome. *J Headache Pain.* 2012;13(8):625-637.
45. Leblebici B, Pektaş Z, Ortancil Ö, et al. Coexistence of fibromyalgia, temporomandibular disorder, and masticatory myofascial pain syndromes. *Rheumatol Int.* 2007;27(6):541-544.
46. Manfredini D, Tognini F, Montagnani G, et al. Comparison of masticatory dysfunction in temporomandibular disorders and fibromyalgia. *Mi-nerva Stomatol.* 2004;53(11-12):641-650.

47. Fraga B, Santos E, Farias Neto J, et al. Signs and symptoms of temporomandibular dysfunction in fibromyalgic patients. *J Craniofac Surg*. 2012;23(2):615-618.
48. Salvetti G, Manfredini D, Bazzichi L, Bosco M. Clinical features of the stomatognathic involvement in fibromyalgia syndrome: a comparison with temporomandibular disorders patients. *Cranio*. 2007;25(2):127-133.
49. Wolfe F, Katz R, Michaud K. Jaw pain: its prevalence and meaning in patients with rheumatoid arthritis, osteoarthritis, and fibromyalgia. *J Rheumatol*. 2005;32(12):2421-2428.
50. da Silva LA, Kaziyama HH, de Siqueira JT, et al. High prevalence of orofacial complaints in patients with fibromyalgia: a case-control study. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2012;114(5):e29-e34.
51. Rhodus N, Friction J, Carlson P, Messner R. Oral symptoms associated with fibromyalgia syndrome. *J Rheumatol*. 2003;30(8):1841-1845.
52. Balasubramaniam R, de Leeuw R, Zhu H, et al. Prevalence of temporomandibular disorders in fibromyalgia and failed back syndrome patients: a blinded prospective comparison study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2007;104(2):204-216.
53. Velly A, Look J, Schiffman E, et al. The effect of fibromyalgia and widespread pain on the clinically significant temporomandibular muscle and joint pain disorders—a prospective 18-month cohort study. *J Pain*. 2010;11(11):1155-1164.
54. Gui MS, Pedroni CR, Aquino LM, et al. Facial pain associated with fibromyalgia can be marked by abnormal neuromuscular control: a cross-sectional study. *Phys Ther*. 2013;93(8):1092-1101.
55. Raphael KG, Marbach JJ. Widespread pain and the effectiveness of oral splints in myofascial pain. *J Am Dent Assoc*. 2001;132(3):305-316.
56. Adiels AM, Helkimo M, Magnusson T. Tactile stimulation as a complementary treatment of temporomandibular disorders in patients with fibromyalgia syndrome. A pilot study. *Swed Dent J*. 2005;29(1):17-25.
57. Stay FP. The fibromyalgia dental handbook. New York. Marlowe & Company. 2005.
58. Leopold D. Disorders of taste and smell. Medscape [Internet]. 1994 [cited 2013 November 25]. Available from: <http://emedicine.medscape.com/article/861242-overview>
59. Weingarten TN, Podduturu VR, Hooten WN, et al. Impact of tobacco use in patients presenting to a multidisciplinary outpatient treatment program for fibromyalgia. *Clin J Pain*. 2009;25(1):39-43.
60. Pamuk ON, Dönmez S, Cakir N. The frequency of smoking in fibromyalgia patients and its association with symptoms. *Rheumatol Int*. 2009;29:1311-1314.
61. DiCecco K. Fibromyalgia. *J Legal Nurse Consult*. 2009;20:20-23.
62. Centers for Disease Control and Prevention. Fibromyalgia [Internet]. 2012 [cited 2013 Oct 30]. Available from: <http://www.cdc.gov/arthritis/basics/fibromyalgia.htm>
63. DeBowes SL, Tolle SL, Bruhn AM. Parkinson's disease: considerations for dental hygienists. *Int J Dent Hyg*. 2012;11:15-21.

Independent Analysis: Efficacy of Sealants Used in a Public Health Program

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Introduction

Sealants are recognized as a preventive tool for averting dental caries.¹⁻³ Multiple studies have validated sealant efficacy, cost/benefit ratios and need for preventing the most common chronic disease in children – dental caries.⁴⁻¹⁵ When sealants are used as part of a public health program, they can reduce the number of lost school days and cost of health care, while improving Quality of Life (QoL).^{9,11-22} This short report details part of the findings of a larger, multiphasic research study considering Quality of Care (QoC) and QoL for socioeconomic and underserved rural populations accessing dental health care through a Public Health Department Program.²³

Caries continue to be the most significant public dental health problem in the U.S.^{2,3,9,11-16,19-21,24-31} Lack of access to oral care and being socioeconomically disadvantaged plagues the population described in this short report.^{3,9,11-14,17} A childhood of dental issues can lead to a lifetime of oral health problems, if early interventions are not implemented.^{1-21,24-31} Relatively low cost easy solutions, including sealant programs, can result in fewer missed school days, while reducing both active disease and pain.^{3,9,13,21} The burden from long-term effects of dental disease on the entire health care system can be reduced using preventive sealant programs.^{1-4,7-15,18,22,25-31}

Methods and Materials

The Price County Public Health Department offers dental hygiene services to clients. Services provided are educational, preventive and treatment oriented. Populations include un-served and underserved clients in rural communities ranging from prenatal to geriatric

Abstract

Purpose: This short report details part of the findings of a larger, multiphasic research study considering Quality of Care (QoC) and Quality of Life (QoL) for socioeconomic and underserved rural populations accessing dental health care through a Public Health Department. Improving oral health for families that are socioeconomically disadvantaged, with cultural disparities, or lacking access to care was the goal of this project. The purpose of this project was documenting effectiveness of oral health care when dental hygienists working through local area health departments, as an alternative delivery model, provide quality educational and preventive care services.

Clinical Outcomes: Over a 6 year period, 1,511 sealants were placed. Simple clinical practices using 4-handed dentistry and strict isolation techniques led to achieving a 95% or higher cumulative sealant retention rate. Dental caries was averted for 858 individuals over a 3 year period (2006 to 2009). Using a consultation-referral model, 463 individuals received restorative care. Results from this short report document clinical care practices for populations in rural communities with limited access to care while improving oral health outcomes.

Conclusion: The clinical findings in this short report illustrate the successes of an oral health care program offered by a dental hygienist working collaboratively through a Community Public Health Department. Sealant retention, averted dental caries and restorative care provided using a consultative-referral model all illustrate clinical quality of care achieved when employing alternative care models outside the realm of traditional in office procedures.

Keywords: quality of life, quality of care, outcomes, health disparities, prevention, education, allied health, dental hygiene, dental sealants

This study supports the NDHRA priority area, **Health Services Research:** Investigate how alternative models of dental hygiene care delivery can reduce health care inequities.

care programming. All program participants and families are educated about nutrition, dental caries prevention, brushing, flossing and fluoride use as part of these programs. Oral screenings are conducted, followed by preventive treatment using a combination of fluoride and sealants based on need. This short report focused on illustrating outcomes associated with sealant use as part of a public health program. The consultative-referral model for clinical service and care is evidence based, and protocols are strictly followed

Table I: Preventive Outcomes

Year	Children Given Sealants in Program	Retention Percent 1 year check	Averted Dental caries	Restorative Referrals Made
2004	314	97.90%	N/A	153
2005	286	96.90%	N/A	83
2006	259	95.00%	367	68
2007	216	97.00%	184	65
2008	236	96.00%	184	57
2009	200	98.3%	123	37
Total	1511	96.85%	858	463

by participating clinicians.^{23,32} State service protocols were developed based on Caries Management by Risk Assessment (CAMBRA) and the Association of State and Territorial Dental Directors (ASTDD).³³⁻³⁶ When restorative care is required, a consultative-referral model is used.^{23,32} Sealant programs, and their resultant preventive outcomes, are not new. This short report documents the outcomes of the sealant component of the overall preventive public health program offered in Price County.

Four-Handed Dentistry/Isolation

Maintaining isolation during any dental procedure can be challenging. Using mobile equipment, lack of consistent air/water pressure during connections, lack of trained personnel providing assistance during procedures or uncooperative patients can cause retention rates to decline.³⁷ Clinicians involved collectively averaged over 10 years of experience placing sealants as part of this program. Four-handed dental procedures using strict isolation including dental dams, coupled with strict adherence to manufacturer’s recommendations during sealant placement were used, which may have significantly impacted sealant retention.³⁷ Dental hygienists new to working for the program completed training and calibration prior to actively participating in providing clinical care. Training and calibration included assessment, use of screening tools, isolation, placement, retention checks and documentation as per service protocols.^{23,32} Strict isolation, training and using 4-handed dentistry techniques were factors that may have positively influenced the reported clinical outcomes found in Table I.

Retention Rates

The success of sealant retention was determined through an examination of patients at both 1 and 2 year intervals post-placement. Researchers did not have access to 2 year retention check data. Visual and tactile examinations were employed using mirrors and explorers for determining if sealant materials were retained in occlusal grooves. The basic screening survey

tool from the ASTDD was used as part of clinical protocol for sealant placement and retention.³²⁻³⁶ This tool is also used for consistent statewide reporting in other counties with public dental health programs. If sealant material was present in grooves, the sealant was considered retained. Partial occlusal sealants were considered retained, and repaired if necessary. Sealant retention rates exceeded 95% for each of 5 years reported (Table I).

Averted Dental Caries

A complex algorithm developed by Epidemiologists at the Centers for Disease Control (CDC) exists for assessing and calculating averted dental caries when data is reported for public dental health programs.³⁸ Researchers at the CDC consider an 85% retention rate a standard benchmark for QoC outcomes.³³ The findings for this program far exceed the established benchmark (Table I). The CDC algorithm requires 2 years of data before averted dental caries can be calculated, thus, no findings were reported for 2004 and 2005. Sealant retention checks had not been conducted for calculating averted dental caries rates in 2009 as data had not yet been collected for analysis. Follow-up data for 2009 were gathered and included for the purpose of completeness in this short report. Dental caries were averted for 858 children during a 3 year period from 2006 to 2009 as illustrated in Table I.

Referrals for Restorative Care

The Price County Public Health Department’s dental hygienist uses a consultative-referral model for patients requiring restorative care.^{23,32} Referrals for restorative care are made by the dental hygienist to Federally Qualified Health Clinics (FQHC) and Community Health Centers (CHC) and/or private dentists for restorative dental services and case management.^{23,32} FQHCs, CHCs and private offices report back to the public health department if individuals are seen and treated. Four hundred and sixty-three referrals were made for restorative care in the service community using this model over a 6 year period. The need for re-

storative care declined over time. Findings are stated in Table I.

Discussion

Some children are at risk for developing dental caries. The findings illustrated in this short report document some important but simple actions that can be used by dental hygienists working in public and community health settings that may improve oral health care outcomes. Using 4-handed dentistry, strict isolation techniques and participant calibration training while following evidence based protocols may have significantly improved retention rates for dental sealants as illustrated in this public health program. If contamination occurs during procedures, it is important to recognize, re-isolate and retreat a surface for improved retention per manufacturers and standard clinical practice guidelines.³⁷ Findings from this short report illustrate following how simple clinical care practices discussed here may significantly impact sealant retention and resultant oral health care outcomes.

According to the Surgeon General, disease burden continues plaguing underserved, minority and socioeconomically disadvantaged populations.^{12,15} Where dental caries can be averted in theory, it is harder to do so in practice. Families with children that are socioeconomically disadvantaged, or have difficulty accessing care because they are demographically at a distance from a provider are at greater risk of developing dental caries.^{2,3,9,11-14,17}

Several recommendations for ongoing research related to how QoC impacting QoL and much broader than the information included in this short report are made here. Further evaluation of impacts of educational and preventive treatment specifically for socioeconomically disadvantaged, racial and ethnic minority groups should be conducted.^{9,13-15,28} Validating efficacy of treatment for children of socioeconomically disadvantaged, racial and ethnic minority groups is necessary. Evaluating risk assessment tools and preventive interventions is also required.^{17,24-26} Studies of effectiveness of primary care providers employing formal risk assessment tools for assessing dental caries would be beneficial.² Risk assessment tools are available, but their effectiveness has not been measured.^{2,17,24-26}

Sealants only prevent dental caries in buccal and lingual pits and on occlusal surfaces. Outcomes data about averted dental caries from the CDC³⁸ does not include interproximal lesions that develop if children and families have poor oral hygiene, dietary habits or developmental structural tooth defects.^{2,3,9,11-14,17}

Caries prevention when using fluoride varnish applications in primary care settings such as Community Public Health Departments should also be analyzed. Further clinical scientific investigation regarding other potential treatments for preventing dental caries, including xylitol, chlorhexidine varnishes or povidone-iodine solutions should be investigated.⁴⁶⁻⁴⁸

Early childhood dental caries causes pain, impaired growth, missed school days and negative effects on QoL.^{2,3,9,11-14,17,44} In turn, these impacts can affect self-esteem, appearance, speech and school performance.^{3,13-15,17} Over 50 million school hours are lost yearly because of childhood dental issues.^{9,13,21} Individuals and families in underserved rural communities that are demographically isolated and socioeconomically disadvantaged often have difficulty accessing care. The service model employed by the Price County Public Health Department provides educational, preventive and restorative clinical care services for patients and families through consultation-referral, potentially impacting their QoL.³²

Community based outcomes for prevention and treatment of dental caries including results from sealant programs at an epidemiologic population level must continue.^{2,38} Where the data in this short report notes averted and declining rates of dental caries over time, findings may also be attributed to the success of employing a consultative-referral model as a bridge for accessing restorative care in rural, demographically isolated communities.^{32,39-48} Findings from all these investigations can support healthier communities and healthier citizens for the 21st century.

Conclusion

The clinical findings in this short report illustrate the successes of an oral health care program offered by a dental hygienist working collaboratively through a Community Public Health Department. Sealant retention, averted dental caries rates, and restorative care provided using a consultative-referral model all illustrate effectiveness of clinical quality of care when employing alternative care models and systems outside the realm of traditional in office procedures.

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References

1. Gooch BF, Griffin SO, Gray SK, et al. Preventing dental caries through school-based sealant programs: updated recommendations and reviews of evidence. *J Am Dent Assoc.* 2009;140(11):1356-1365.
2. Chou R, Cantor A, Zakher B, Mitchell JP, Pappas M. Preventing dental caries in children <5 years: systematic review updating USPSTF recommendation. *Pediatrics.* 2013;132(2):332-50.
3. Caulfield PW, Griffen AL. Dental caries: an infectious and transmissible disease. *Pediatr Clin North Am.* 2000;47(5):1001-1019.
4. Griffin SO, Oong E, Kohn W, et al. The effectiveness of sealants in managing caries lesions. *J Dent Res.* 2008;87(2):169-174.
5. Hiiri A, Ahovuo-Saloranta A, Nordblad A, Mäkelä M. Pit and fissure sealants versus fluoride varnishes for preventing dental decay in children and adolescents. *Cochrane Database Syst Rev.* 2006;(4)CD003067.
6. Beauchamp J, Caufield PW, Crall JJ, et al. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association Council on Scientific Affairs. *Dent Clin North Am.* 2009;53(1):131-147.
7. Armfield JM, Spencer AJ. Community effectiveness of fissure sealants and the effect of fluoridated water consumption. *Community Dent Health.* 2007;24(1):4-11.
8. Nilchian F, Rodd HD, Robinson PG. The success of fissure sealants placed by dentists and dental care professionals. *Community Dental Health.* 2011;28(1):99-103.
9. Casamassimo PS, Thikkurissy S, Edelstein BL, Maiorini E. Beyond the dmft: the human and economic cost of early childhood caries. *J Am Dent Assoc.* 2009;140(6):650-657.
10. Nainar SM, Tinanoff N. Effect of Medicaid reimbursement rates on access to dental care. *Pediatr Dent.* 1997;19(5):315-316.
11. National Center for Health Statistics. Healthy People 2010 Final Review. National Center for Health Statistics. 2012.
12. U.S. Department of Health and Human Services. Oral Health in America: A Report of the Surgeon General. U.S. Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health. 2000.
13. Dye BA, Tan S, Smith V, et al. Trends in oral health status: United States, 1988–1994 and 1999–2004. *Vital Health Stat 11.* 2007;(248):1-92.
14. Kawashita Y, Kitamura M, Saito T. Early childhood caries. *Int J Dent.* 2011;2011:725320.
15. Tinanoff N, Reisine S. Update on early childhood caries since the Surgeon General's report. *Acad Pediatr.* 2009;9(6):396-403.
16. U.S. Department of Health and Human Services. Oral Health in America: A Report of the Surgeon General. U.S. Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health. 2000.
17. Bader JD, Rozier RG, Lohr KN, Frame PS. Physicians' roles in preventing dental caries in preschool children: a summary of the evidence for the U.S. Preventive Services Task Force. *Am J Prev Med.* 2004;26(4):315-325.
18. Centers for Disease Control and Prevention. Promoting oral health: interventions for preventing dental caries, oral and pharyngeal cancers, and sports-related craniofacial injuries. A report on the recommendations of the Task Force on Community Preventive Services. *MMWR Recomm Rep.* 2001;50(RR-21):1-13.
19. Selwitz RH, Ismail AI, Pitts NB. Dental caries. *Lancet.* 2007;369(9555):51-59.
20. Centers for Disease Control and Prevention. Dental Caries: Hygiene-Related Diseases. Centers for Disease Control and Prevention. 2009.
21. Jackson SL, Vann WF Jr, Kotch JB, Pahel BT, Lee JY. Impact of poor oral health on children's school attendance and performance. *Am J Public Health.* 2011;101(10):1900-1906.
22. Vargas CM, Crall JJ, Schneider DA. Sociodemographic distribution of pediatric dental caries; NHANES III, 1988-1994. *J Am Dent Assoc.* 1998;129(9):1229-1238.
23. Olmsted JL, Rublee N, Zurkawski E, Kleber L. Public health dental hygiene: an option for improved quality of care and quality of life. *J Dent Hyg.* 2013;87(5):299-308

24. U.S. Department of Health and Human Services. National call to action to promote oral health: A public-private partnership under the leadership of the office of the surgeon general. U.S. Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health. 2003.
25. Amschler DH. A hidden epidemic:dental disparities among children. *J Sch Health*. 2003;73(1):38-40
26. Edelstein BL. Disparities in Oral Health and Access to Care: Findings of National Surveys. *Ambul Pediatr*. 2002;2(2 Suppl):141-147.
27. The cost of delay: state dental policies fail one in five children. Pew Charitable Trust [Internet]. 2010 [cited 2015 March 26]. Available from: <http://www.pewtrusts.org/en/research-and-analysis/reports/2010/02/23/the-cost-of-delay-state-dental-policies-fail-one-in-five-children>
28. Zust BL, Moline K. Identifying Ethnic Populations Within a Community: The First Step in Eliminating Health Care Disparities Among Racial and Ethnic Minorities. *J Transcult Nurs*. 2003;14(1):66-74.
29. Harris R, Nicoll AD, Adair PM, Pine CM. Risk factors for dental caries in young children: a systematic review of the literature. *Community Dent Health*. 2004;21(Suppl 1):71-85.
30. Improving Access to oral Health Care for Vulnerable and Underserved Populations. Institute of Medicine [Internet]. 2011 [cited 2015 March 23]. Available from:<http://www.iom.edu/oralhealth>
31. Beltrán-Aguilar ED, Barker LK, Canto MT, et al. Surveillance for Dental Caries, Dental Sealants, Tooth Retention, Edentulism, and Enamel Fluorosis --- United States, 1988--1994 and 1999--2002. Center for Disease Control and Prevention. 2005.
32. Rublee N. Price County seal a smile dental sealant agency protocol. Department of Health and Family Service, Division of Public Health [Internet]. 2005. Available from: http://www.cphfoundation.org/documents/PriceCountyWIOtherPHPrevention_000.pdf.
33. Featherstone JD, Domejean-Orliaguet S, Jenson L, Wolff M, Young DA. Caries risk assessment in practice for age 6 through adult. *J Cal Dent Assoc*. 2007;35(10):703-713.
34. Jenson L, Budenz AW, Featherstone JD, Ramos-Gomez FJ, Spolsky VW, Young DA. Clinical protocols for caries management by risk assessment. *J Cal Dent Assoc*. 2007;35(10):714-723a.
35. Spolsky LW, Black BP, Jenson L. Old, new, and emerging. *J Cal Dent Assoc*. 2007;35:724-737.
36. Featherstone JD, Roth JR. Cariology in the newworld order: moving from restoration toward prevention. *J Cal Dent Assoc*. 2003;31:129-133.
37. Munoz H, Carver-Silva J. Pit and fissure sealants: an overview. *RDH*. 2013;33(10):95-100.
38. Jones K. Cumulative Sealant Retention Rates and Contraindications. Centers for Disease Control and Prevention. 2010.
39. Liu J, Probst JC, Martin AB, Wang JY, Salinas CF. Disparities in dental insurance coverage and dental care among US children: the National Survey of Children's Health. *Pediatrics*. 2007;119(Suppl 1):S12-S21.
40. Niederman R, Gould E, Soncini J, Tavares M, Osborn V, Goodson J. A model for extending the reach of the traditional dental practices: the Forsyth Kids program. *J Am Dent Assoc*. 2008;139(8):1040-1050.
41. Derkson D, Formicolo A, Marguerite R. Strengthening the oral health safety net: delivery models that improve access to oral health care for uninsured and underserved populations. *Am J Public Health*. 2004;94(5):702-704.
42. Nash DA. Expanding dental hygiene to include dental therapy: improving access to care for children. *J Dent Hyg*. 2009;83(1):36-44
43. Nainar SM, Tinanoff N. Effect of Medicaid reimbursement rates on access to dental care. *Pediatr Dent*. 1997;19(5):315-316.
44. Hyde S, Satariano WA, Weintraub JA. Welfare dental intervention improves employment and quality of life. *J Dent Res*. 2006;85(1):79-84.
45. U.S. Preventive Services Task Force. Prevention of dental caries in preschool children: recommendations and rationale. *Am J Prev Med*. 2004;26(4):326-329.
46. Anderson MH. Current Concepts of Dental Caries and its Prevention. *Oper Dent*. 2001;6:11-18.
47. Featherstone JD. Delivery challenges for fluoride, chlorhexidine, and xylitol. *BMC Oral Health*. 2006;1:58.
48. Best Practice Approach: Prevention and Control of Early Childhood Tooth Dental decay. Association of State & Territorial Dental Directors [Internet]. 2010 [cited February 2010]. Available from: <http://www.astdd.org/docs/BPAEarlyChildhood.pdf>

Barriers Faced by Expanded Practice Dental Hygienists in Oregon

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Introduction

It has been over a decade since the U.S. Surgeon General issued a report stating that oral health is an essential component of overall health.¹ Yet getting access for all populations to quality dental care is still a major concern - reports consistently document a shortage of dentists in rural and inner city communities, and marginalized populations that do not receive regular dental care, with 45 million people living in these areas.² It has been proposed that expanding the role of dental hygienists is one way to increase access to care for the underserved.^{3,4}

In order to expand opportunities for dental hygienists and improve access to care, some states and countries utilize a mid-level practitioner in the dental field. Examples include the Dental Health Aide Therapist in New Zealand, the Dental Health Aide Therapist in Alaska, and the Dental Therapist, as well as the Advanced Dental Therapist, in Minnesota. Mid-level providers can perform a wide range of clinical services such as basic restorative procedures and extractions, in addition to the traditional repertoire of dental hygiene services.⁵⁻⁷ While most states do not utilize a mid-level practitioner, over the past decade many states have expanded the legal scope of practice of dental hygienists.⁸ Currently, 35 states allow dental hygienists to initiate patient care in a setting outside of the private dental office without the presence of a dentist in what the American Dental Hygienists' Association (ADHA) defines as direct access states.⁹ The term direct access means that the dental hygienist can initiate treatment based on his or her assessment of patients' needs without the specific au-

thorization of a dentist, treat patients without the presence of a dentist and can maintain a provider-patient relationship.¹⁰

Abstract

Purpose: Oregon allows dental hygienists to provide services without the supervision of a dentist if they hold an expanded practice permit (EPP). This study surveyed practicing and non-practicing EPP holders with the purpose of assessing perceived barriers to practicing independently and better educating students to begin independent practice upon graduation.

Methods: A survey was developed, approved by the institutional review board and pilot tested with current Expanded Practice Dental Hygienists (EPDHs). A list of EPDHs was obtained from the Oregon State Dental Board, and 181 surveys were mailed in November 2011.

Results: The response rate was 39% (n=71). Data from this study indicate a large number of new EPP holders, with 62% (n=41) holding their permit for 3 years or less, but only 41% (n=29) of respondents are actually providing care in a setting requiring an EPP. Responding practicing EPDHs reported barriers including: challenges with insurance reimbursement, lack of knowledge/acceptance, equipment cost/maintenance, difficulty obtaining a collaborative agreement/cooperating facility, advertising and inability to make a living wage. Responding non-practicing EPDHs reported barriers including: currently working in another setting, lack of business knowledge, time, start-up cost, inability to make a living wage, lack of opportunity, reimbursement difficulties and lack of experience.

Conclusion: Perceived barriers to practicing independently differ between those practicing utilizing their EPP and those not practicing. Ways to eliminate barriers for both practicing and non-practicing EPDHs should be explored. There is potential to reduce the barriers to independent practice through curricular changes, public health partnerships among EPDHs, and new health care systems that specifically address barriers found through this study.

Keywords: dental Hygiene extended practice permits, access to oral health care, direct access, independent practice, dental hygiene, limited access, expanded practice

This study supports the NDHRA priority area, **Health Services**

Research: Investigate how alternative models of dental hygiene care delivery can reduce health care inequities.

In the state of Oregon a mid-level practitioner does not exist, however, direct access does. Legislation was passed in 1997 to allow dental hygienists to attain a limited access permit.¹¹ Legislation was later passed in 2012 renaming the limited access permit to the expanded practice permit (EPP). The EPP enables dental hygienists to provide a variety of dental hygiene services, without the supervision of a dentist, for "limited access" regions or populations (Figure 1). Expanded practice dental hygienists (EPDHs) are required to refer patients to a dentist at least once annually for examination and treatment of active dental disease. EPDHs do not need a collaborative agreement with a dentist to initiate dental hygiene care for patient populations that qualify as having limited access to care. If an EPDH wishes to perform additional services, such as providing local anesthesia, placing temporary restorations, and prescription of prophylactic antibiotics and non-steroidal anti-inflammatory drugs (NSAIDs) (which are included in the law), they must have a collaborative agreement with a dentist to provide those additional services. Many EPDHs work as employees in non-dental settings like nursing homes or schools. Other EPDHs become private business owners. One pathway to obtain an EPP is to have 2,500 hours of clinical dental hygiene practice and complete 40 hours of continuing education of the individual's choosing. An additional pathway to obtaining an EPP credential is to complete a course of study approved by the Oregon State Dental Board and have at least 500 hours of dental hygiene practice on patients in "limited access" settings while under the direct supervision of dental or dental hygiene faculty of an accredited program (Figure 2). Until October 2010, there were no board-approved courses of study.¹² At that time, the Oregon Legislature passed a bill allowing applicants to apply hours spent during training (dental hygiene school) with patients in underserved or limited access settings to their 500-hour quota. Thus, under recently amended legislation, students are potentially able to attain an EPP upon graduation.

The goal of recent legislative changes is to facilitate a significant improvement in the access to care crisis in Oregon. To date, however, limited information exists regarding the impact of expanded practice dental hygienists as well as the barriers faced in pursuing expanded practice. The only study to date of Oregon EPDHs was conducted in 2005 by Battrell et al.¹³ This qualitative study included 7 Oregon EPDHs as well as 2 dentists. Participants perceived a need for expansion of scope of education to prepare for independent practice and called for additional curricular experiences to include coursework on organizational structure,

Figure 1: Practice Settings in Which EPDHs Are Allowed to Work

Expanded Practice Settings:
<p>An expanded practice dental hygienist may render all services within the scope of practice of dental hygiene without the supervision of a dentist to patients of the following facilities or programs who, due to age, infirmity or disability, are unable to receive regular dental hygiene treatment:</p> <ul style="list-style-type: none"> • Nursing homes • Adult foster homes • Residential care facilities • Adult congregate living facilities • Mental health residential programs • Facilities for mentally ill persons • Facilities for persons with developmental disabilities • Local correctional facilities and juvenile detention facilities • Public and nonprofit community health clinics • Adults who are homebound • Students or enrollees of nursery schools and day care programs and their siblings under 18 years of age • Primary and secondary schools, including private schools and public charter schools • Persons entitled to benefits under the Women, Infants and Children Program • Patients in hospitals, medical clinics, medical offices or offices operated by nurse practitioners, physician assistants or midwives. • Patients whose income is less than the federal poverty level • Other populations that the Oregon Board of Dentistry determines are underserved or lack access to dental hygiene services

Figure 2: Criteria Which Must be Met to Obtain an Expanded Practice Permit

Expanded Practice Permit Criteria:
<p>To receive an expanded practice permit, dental hygienists must:</p>
<p>Pathway 1</p> <ul style="list-style-type: none"> • Hold a valid, unrestricted Oregon dental hygiene license • Present proof of current professional liability insurance • Completed 2,500 hours of supervised dental hygiene practice • Completed 40 hours of courses, chosen by applicant in: <ol style="list-style-type: none"> 1. Clinical dental hygiene 2. Public health
<p>Pathway 2</p> <ul style="list-style-type: none"> • Complete a course of study approved by the board that includes 500 hours of dental hygiene practice, completed before or after graduation from a dental hygiene program on limited access patients while under the supervision of a member of the faculty of a dental program or dental hygiene program accredited by the Commission on Dental Accreditation of the American Dental Association.

billing, coding, prescription writing and the public health delivery system. One dental hygiene school in Oregon, Pacific University, has implemented curricular changes aimed at decreasing the barriers to entering independent practice, but the influence these courses have on the likelihood of graduates pursuing independent practice has not been measured. The perceived barriers to date have also not been formally measured.

This study surveyed current EPDHs, both practicing and non-practicing, with the purpose of assessing perceived barriers to practicing unsupervised and better educating students to begin EPP practice upon graduation. Specific research questions included:

- If participants are currently practicing as an EPDH, what specific barriers do they face that make it challenging to practice in this role?
- If participants are not currently practicing as an EPDH, what specific barriers have kept them from practicing in that role?
- Do specific characteristics like level of education, years since graduation, or years holding an EPP increase the likelihood of utilizing the expanded practice permit?
- How well does a specific institution which grants at least 500 hours of practice on patients in "limited access" settings prepare students to begin independent practice upon graduation based on reported barriers?

The results of this study will be used to advise students, further develop the dental hygiene curriculum at the authors' institution in support of independent practice and to suggest future directions for eliminating barriers to independent practice in Oregon as a whole to address the need for improved access to care.

Methods and Materials

In the fall of 2011, a list of all current EPDHs was obtained from the Oregon Board of Dentistry (n=186). A convenience sample of 2% was selected to pilot test the survey. Subsequent revisions were made according to feedback from the pilot testers. Following approval of the Pacific University Institutional Review Board with exempt status, the survey was mailed to all EPDHs in the state of Oregon in November 2011, with the exception of those included in the pilot test. Data were collected using a self-administered survey. A follow-up mailing was sent in December 2011 to all non-respondents. To maintain confidentiality, the surveys were numerically coded. The linkage file was maintained solely to facilitate the second mailing (a

second survey was only sent to non-respondents). Once data collection was completed, the linkage file was destroyed. The mailing included a consent document explaining the purpose of the study and that it was confidential. In addition to a copy of the survey and the consent document, a business reply envelope was included (signed consent was not requested; consent was implied by return of the questionnaire).

The 16-item questionnaire contained both closed and open-ended questions that assessed the following areas: demographics, income from EPDH practice, amount of services provided, details of EPDH practice and perceived barriers to practicing as an EPDH. This article focuses on the demographics and perceived barriers sections. The amount of services provided and details of EPDH practice has been addressed in a separate report.¹⁴

When analyzing open-ended qualitative data related to barriers, 2 investigators determined preliminary categories to be able to do quantitative analysis of the data. Each investigator categorized the answers individually and the answers were then compared. Additional categories were added if at least 3 individuals answered similarly. If a response had less than 3 respondents reporting similarly the response was placed in the "other" category. Anywhere consensus could not be reached on a particular answer it was also placed in the "other" category. Ultimately, open-ended responses were categorized numerically for the purpose of statistical analysis.

The data were analyzed using SPSS (version 20, IBM). Frequency distributions are provided to describe the findings, and Chi-square tests using the Freeman-Halton extension of the Fisher exact test were used to investigate whether possible factors such as length of time holding EPP, level of education and years since graduation influenced the likelihood of EPDHs to be practicing in a setting which requires an EPP. For level of education, the sample contained 2 certificate holders; therefore, Certificate/Associates degrees were combined.

Results

The response rate for the survey of EPDHs was 39% (n=71). Approximately 41% (n=29) of the respondents were currently using their EPP and an additional 21% (n=15) were planning to start their own independent practice. The average age of the EPDH was 49, with a range of reported ages from 25 to 71 years of age. Sixty-two percent of the sample has held their EPP for 3 years or less (n=41). Of the current practicing EPDHs, the average weekly

hours working unsupervised is 9.3 hours (n=25). On average, unsupervised practice comprises 22% of their total annual income (n=27). The highest level of education held by the sample was a bachelor's degree (58%, n=39). All demographic data is summarized in Table I.

Barriers faced by EPDHs were examined for both practicing and non-practicing EPDHs. The number of responses is larger than the sample size for each group because participants were allowed to report multiple barriers. For non-practicing EPDHs the most frequently perceived barriers were: currently working in another setting (21%, n=14), lack of business knowledge (15%, n=10), time (10%, n=7), inability to make a salary/living wage (10%, n=7) and start-up costs (10%, n=7) (Figure 3).

For practicing EPDHs, the most frequently cited barriers were: challenges with insurance reimbursement (39%, n=13), lack of knowledge/acceptance (21%, n=8), equipment cost/maintenance (11%, n=4), and lack of collaborative agreement/cooperating facility (11%, n=4) (Figure 4).

Chi-square tests using the Freeman-Halton extension of the Fisher exact test were used to explore possible relationships contributing to the likelihood of EPDHs to be practicing currently. While no statistically significant results were found, there were several trends identified in the sample of practicing EPDHs. The highest percentage of practicing EPDHs have held their EPP for 3 years or less at 21% (n=14) (Table II). The highest percentage of practicing EPDHs held a Bachelors degree or an Associates/Certificate at 19% (n=13) and 18% (n=12), respectively (Table III). The largest percent of practicing EPDHs had greater than 20 years since graduation, 20% (n=14) (Table IV).

Discussion

Although some form of the EPP has existed in Oregon since 1997, the largest percentage of the existing EPDHs have only had their permit for 3 years or less, which indicates an increasing support of Oregon dental hygienists for unsupervised practice. According to the Oregon dental board, the number of EPDHs in Oregon has increased from 186 to 356 since this survey was completed. This is a near double increase in the past 2 years. This increase is likely due to the ability to obtain an EPP through the new pathway (pathway 2). While the majority have held their permit for 3 years or less, nearly half the sample of EPDHs are over 50 years old and have been out of dental hygiene school for longer than 20 years. This suggests that dental hygienists who have been prac-

Table I: Descriptive Statistics of Responding EPDHs

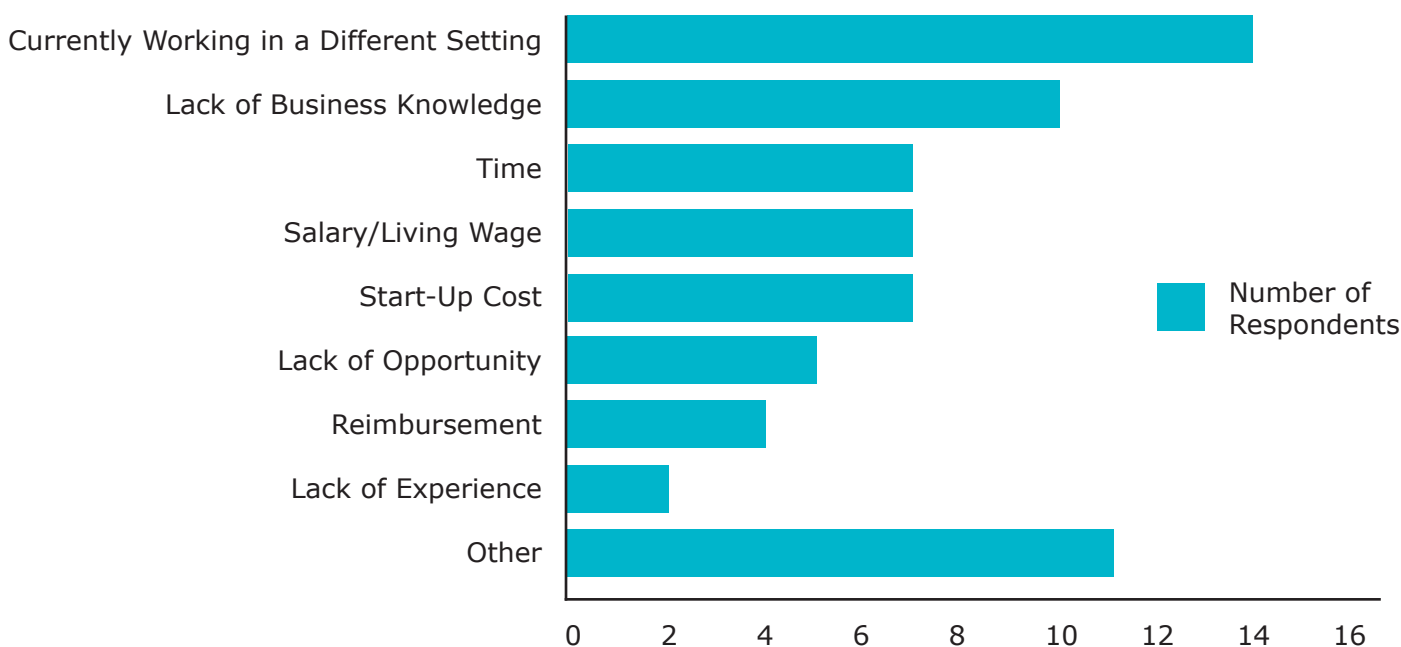
	Category	n	Percent
Age by Category (n=70)	20 to 30	6	9%
	31 to 40	10	14%
	41 to 50	15	21%
	>50	39	56%
Years held EPP (n=66)	0 to 3	41	62%
	4 to 6	9	14%
	7 to 9	5	8%
	≥10	11	17%
Practicing using EPP (n=71)	41%	-	-
Mean Hours Per Week using EPP (n=25)	9.3 (Std. Dev. 12.47)	-	-
Income from EPP (n=27)	≤10,000	18	67%
	10,001 to 20,000	4	15%
	20,001 to 30,000	3	11%
	30,001 to 40,000	1	4%
	40,001 to 50,000	0	0%
	>50,000	1	4%
Level of Education (n=67)	Certificate Associate	2	3%
	Bachelors	22	33%
	Masters	39	58%
		4	6%

*Not every respondent answered every question. The number of respondents who answered each is indicated in the left column. Percentages may not total 100% due to rounding.

ting traditionally show strong interest in moving toward alternative settings to provide care. Authors attempted to evaluate whether concrete demographic characteristics like level of education, number of years holding an EPP and years since graduation influenced the likelihood of EPP holders to be practicing. Unfortunately, a significant indicator of whether participants were more likely to be utilizing their EPP to provide care was not found in this study. Characteristics that influence the likelihood of EPP holders to be practicing are much more difficult to measure, although one previous study found that a motivation to attain independent decision making and a strong dedication to providing services to underserved populations influence the likelihood of individuals to practice using their EPP.¹³

The data demonstrate that both practicing and non-practicing EPDHs perceive similar barriers to providing care to underserved populations. Both groups cited insurance reimbursement as a challenge, but a much higher percentage (61%) of practicing EPDHs reported reimbursement as an

Figure 3: Perceived Barriers of Non-Practicing EPDHs (n=46)



*Total barriers exceeds number of participants because many participants reported more than one barrier.

issue and nearly half stated they have never received insurance reimbursement. This is contrary to what was reported in the Dental Hygiene Professional Practice Index, which gave Oregon a rank of excellent in the area of reimbursement compared to other states with independent practice legislation.¹⁵ Non-practicing EPDHs reported reimbursement as a concern but much less so than practicing with only 4 individuals citing it as a barrier. This is most likely perceived as less of a challenge due to lack of experience in providing care in a limited access setting.

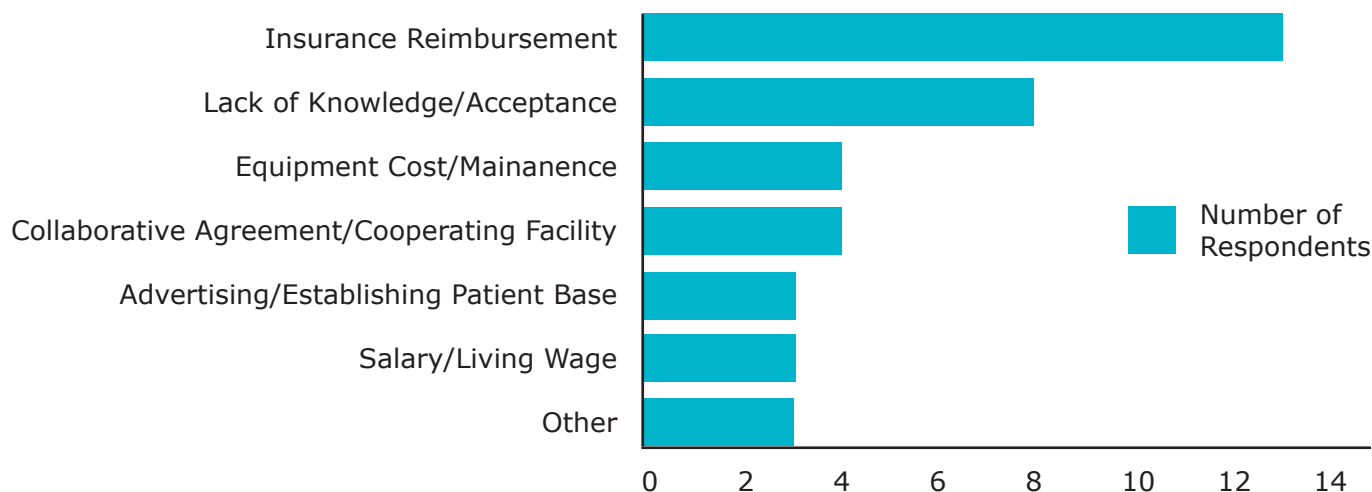
It has been suggested that expanding the practice of dental hygienists could be a potentially significant income source.¹⁶ Yet both groups saw the inability to make a decent salary or living wage as a barrier. This study's findings suggest the majority of practicing EPDHs make less than \$10,000 a year using their EPP. A larger percent of non-practicing EPDHs, 15% compared to 10% of practicing EPDHs, saw this as a barrier. This may indicate that motivation for those utilizing their EPP is not directly linked to the income that it provides. Other motivating factors cited by Battrell et al included the desire to obtain independent decision making and a strong desire to serve underserved populations.¹³ These factors may outweigh the need for independent practice to supply a significant portion of income to those utilizing it.

Finally, both groups cited lack of knowledge as a barrier. Non-practicing EPDHs reported lack of

knowledge regarding how to begin an independent practice, business knowledge and knowledge of the laws. Participants of the 2005 qualitative study of Oregon EPDHs identified a sense of entrepreneurship and marketing skills as keys to success.¹³ In addition, Astroth, et al report that the majority of independently practicing dental hygienists in Colorado had additional education in business management.¹⁷ For non-practicing EPDHs there is an apparent necessity of education associated with starting a business as well as a call for understanding the most current legislative advances in independent practice for dental hygienists in Oregon. Practicing EPDHs reported a different type of lack of knowledge which relates to acceptance and education on the part of dentists and the community. This included lack of knowledge for caregivers regarding the services provided by EPDHs, as well as lack of knowledge in the community as to what EPDHs can do. Removing this barrier would require additional education for the communities in which EPDHs serve.

Many barriers cited were unique to either practicing or non-practicing EPDHs. A barrier faced by practicing EPDHs was equipment cost and maintenance. In addition, establishing a patient base and advertising services were also cited as barriers. When minimal salary and ability to get reimbursed for services is low, unexpected costs of equipment and uncertainty of available patients to treat threaten EPDHs ability to continue providing care to underserved populations. As independent practice becomes more common,

Figure 4: Perceived Barriers of Practicing EPDHs (n=21)



*Total barriers exceeds number of participants because many participants reported more than one barrier.

options to reduce barriers for EPDHs already practicing become extremely important.

Another barrier faced only by practicing EPDHs is securing a collaborative agreement with a dentist. A collaborative agreement allows an EPDH to administer local anesthetic and gives the EPDH additional prescriptive power. Lack of dentists' support for hygienists practicing independently has also been reported in other studies.^{16,18} One reason dentists may not support independently practicing dental hygienists is the perceived threat they may pose to patients seeking care from a dentist. However, having care provided by an independently practicing dental hygienist may not necessarily deter patients from seeking routine dental care. This item was specifically measured in a survey of patients treated by independently practicing dental hygienists in California. In that study, at the 24 month follow-up almost 90% of the patients had been seen by a dentist within 12 months of being treated by an independently practicing hygienist.^{19,20} It appears that, in California, patients who are treated by independently practicing dental hygienists are not less likely to seek routine care from a dentist as a result. In addition, EPDHs in Oregon are required by law to refer patients at least once per year to a dentist who is available to treat them. If patients treated in Oregon are similar to those treated in California, triage care with referral provided by the dental hygienist may increase the rate at which this population seeks care with a dentist. Further research is necessary to test this hypothesis.

The largest barrier seen by non-practicing EPDHs is that they are currently practicing somewhere else. These settings ranged from private

practice to public health and education. While working in another setting might be viewed as more of a personal choice rather than a barrier, participants stated it was a barrier. Another barrier reported was a lack of opportunity which may more accurately represent why working in another setting was cited. While holding an EPP shows strong support for dental hygienists practicing in unsupervised settings, additional barriers such as start up costs, too few internship settings and mentors, and lack of experience are preventing EPP holders from entering into unsupervised practice. When EPDHs spend the majority of their time practicing elsewhere there is little time to pursue the elimination of other barriers. With a growing number of EPDHs in the state of Oregon, there is a responsibility to give individuals the tools necessary to begin practicing independently so that this practice model does in fact reduce the access to care issue.

Non-practicing EPDHs had a variety of barriers that keep them from utilizing their EPP. Reasons varied widely which is why the "other" category received the second most responses. Since 3 or more respondents who cited a particular barrier were required to become a category, many responses were placed in the "other" category. Some examples included: "I'm holding an EPP in support for advancement of the profession but have no personal interest in using it," "I just haven't branched out yet, although I live in an underserved area," "I'm late in my career" and "I am not currently practicing."

Implications for Education

The addition of pathway 2 to the Practice Act has made it easier for new graduates to obtain

an EPP. Targeting the population of new dental hygiene graduates who have not already obtained employment could potentially increase the number of hygienists practicing independently since already working in another setting was the greatest barrier for non-practicing EPDHs. Many of the documented barriers found through this study for both practicing and non-practicing EPDHs could be reduced through additional curriculum focused on practicing independently. With 35 states allowing direct access, the question of educating new dental hygienists to pursue this career path must be addressed. Argument could be made that educators have the responsibility to prepare students for the additional professional aspects of direct access in the states that allow it.

Currently, the Commission on Dental Accreditation (CODA) standards do not explicitly require dental hygiene programs to educate students on aspects relating to independent practice. However, CODA does require graduates to be competent in assessing, planning, implementing and evaluating community based oral health programs including health promotion and disease prevention activities, and the curriculum must include content in community dental/oral health.²¹ CODA concepts that relate to independent practice are the ability to competently plan and implement community based oral health programs with the intention that students will be able to apply community dental health principles to prevent disease and promote health. With dental hygiene curriculums already being tightly constructed, it is difficult to entertain the idea of adding

Table II: Percent of Practicing EPDHs Based on Length of Time Holding EPP (n=66)

Length of Time Holding EPDH	Practicing EPDH	Non-Practicing EPDH
0 to 3 years	21% (n=14)	41% (n=27)
4 to 6 years	8% (n=5)	6% (n=4)
7 to 9 years	3% (n=2)	5% (n=3)
10 years or longer	11% (n=7)	6% (n=4)
		Freeman-Halton extension of the Fisher exact p=0.29

*Percentages may not total 100% due to rounding.

Table III: Percent of Practicing EPDHs Based on Degree Type (n=67)

Degree Type	Practicing EPDH	Non-Practicing EPDH
Certificate/Associates	18% (n=12)	18% (n=12)
Bachelors	19% (n=13)	39% (n=26)
Masters	3% (n=2)	3% (n=2)
		Freeman-Halton extension of the Fisher exact p=0.46

Table IV: Percent of Practicing EPDHs Based on Years Since Graduation (n=70)

Years Since Graduation	Practicing EPDH	Non-Practicing EPDH
Less than 5 years	1% (n=1)	16% (n=11)
6 to 10 years	7% (n=5)	4% (n=3)
11 to 20 years	13% (n=9)	14% (n=10)
Greater than 20 years	20% (n=14)	24% (n=17)
		Freeman-Halton extension of the Fisher exact p=0.053

*Percentages may not total 100% due to rounding.

additional material. Authors believe that courses being taught to fulfill these CODA requirements could slowly begin to incorporate independent practice as a topic. This is a good starting point and may already exist in many schools, but does not address all of the barriers perceived to entering independent practice.

At one educational institution in Oregon, Pacific University, curricular changes have been implemented to reduce the barriers for students graduating with the intention of practicing independently with limited access populations. Specific curricular changes address the barriers of lack of experience, business knowledge, and reimbursement. These include an expanded practice rotation, implemented in 2011, where stu-

dents provide dental hygiene services in limited access settings to gain experience with this patient population. For this rotation, students work alongside an EPDH to see firsthand what goes into practicing independently. In addition, students take an independent practice course in the summer of their senior year, also implemented in 2011. This course gives an overview of independent practice for dental hygienists including state regulation, employment opportunities, business models, marketing, reimbursement and community relations.

Business knowledge is also a key piece to having a successful independent practice and lack of business knowledge was reported as a barrier by non-practicing EPDHs. Since 2007, students at Pacific University have taken a business management course where they learn basic principles of business with emphasis on application of business management skills in dental health care settings.

Cultural competence has also been reported as an important skill for expanded practice dental hygienists in Oregon due to a large number of Hispanic populations being seen by EPDHs.¹³ While this was not an aspect directly measured in this study, it is an additional way Pacific University prepares students to work with limited access patients. Since the program's inception, students have been required to take 2 semesters of Spanish for dental professionals and treat primarily Spanish speaking patients in the school's clinic as well as many of their off campus rotations.

Although Pacific graduates comprised only 9% of the EPDHs in the current survey, at the time Pacific had only graduated 4 cohorts of students. According to the Oregon dental board, since this study was completed the percent of Pacific University graduates holding an EPP has grown from 9 to 27% of the total EPP holders in Oregon. While the percentage of EPP holders who graduated from Pacific has grown significantly since many curricular changes were implemented, whether these changes have influenced their likelihood to practice in a setting which requires an EPP is yet to be measured. It is apparent, at least at one school in Oregon, that the addition of pathway 2 has been a successful way to increase the number of EPP-holders in the state.

Unfortunately, not all the barriers discovered through this study can be addressed in education. There are still many practicing and non-practicing EPDHs who have completed their education and need support to enter independent practice

in Oregon. The current sample is also primarily older and more experienced. Potential avenues to addressing these barriers are: business focused continuing education courses for individuals holding an EPP and mentorship programs with currently practicing EPDHs. Other avenues could include enlisting the help of community leaders, community clinics, Head Start programs and long term care facilities. The solution will no doubt need to be a multi-faceted endeavor.

Study Limitations

There were several limitations to this study, with one of the most significant being the sample size. Because this survey was also an outcomes assessment asking EPDHs to report the amount of services provided and details of EPDH practice, EPP holders who are not currently practicing may not have thought the survey was applicable to them. The questions about perceived barriers were at the end of the survey. This limitation had an impact on the ability to conduct statistical analysis because there were not enough practicing and non-practicing EPDHs in each of the categories to be able to find any statistical significance. An additional limitation was anticipating how modest a salary EPDHs received with \$10,000 or less being the only possible option, which many EPDHs reported making much less than \$10,000 annually. If this had been an open-ended question, it would have better allowed for reporting smaller income ranges. When asked about reimbursement, a large number of practicing EPDHs reported never receiving any reimbursement but several individuals wrote in that they had never tried. This would have been a valuable option that was not included. Finally, the authors were not able to establish survey performance reliability. The survey has been administered only 1 time, so test-retest reliability could not be determined. In order to keep the survey to a minimal length, no redundant questions were included to evaluate internal reliability. To facilitate data entry and consistency of information, every survey mailed was identical, so no alternate-form reliability was established.

Recommendations for future research include exploring how curricular changes have influenced Pacific University graduates' likelihood to enter into independent practice settings. Whereas the business management and Spanish course have existed since the beginning of the program in 2006, the expanded practice rotation and independent practice course have only been taught since the fall of 2011 when this survey was conducted. In addition, investigating how dental hy-

giene programs in other states with some type of independent practice prepare their students to pursue this avenue of providing care is important. Opinions as to whether dental hygiene programs should have the task of preparing dental hygienists to practice unsupervised in direct access states or if it should be done through other pathways should also be examined.

Conclusion

Data from this study indicate that there are an increasing number of new EPP holders in Oregon, but less than half are actually providing care as an EPDH to underserved populations. Lack of business knowledge, lack of experience, insurance reimbursement, start-up costs and the inability to make a living wage are barriers non-practicing EP-

DHs face when deciding whether or not to utilize their EPP. If these barriers can be addressed during dental hygiene education, the potential exists to increase the number and impact of EPDHs in Oregon. For dental hygienists who have already completed their education without the benefit of new curriculum, addressing independent practice, continuing education courses in business management and independent practice strategies, and paid internships with experienced expanded practice dental hygienists may also be helpful in facilitating the transition to independent practice and to facilitate increased access to care.

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References

1. U.S. Department of Health and Human Services. Oral health in America: a report of the Surgeon General. U.S. Department of Health and Human Services, National Institute of Dental and Craniofacial Research, National Institutes of Health. 2000.
2. U.S. Department of Health and Human Services Health Resources and Services Administration. Shortage designation: health professional shortage areas & medically underserved areas/populations. U.S. Department of Health and Human Services Health Resources and Services Administration. 2012.
3. Haden NK, Catalanotto FA, Alexander CJ, et al. Improving the oral health status of all Americans: roles and responsibilities of academic dental institutions: the report of the ADEA President's Commission. *J Dent Educ.* 2003;67(5):563-583.
4. American Dental Hygienists' Association. Access to care position paper. [Internet]. 2013 Feb [cited 2013 Feb 8]. Available at: http://www.adha.org/resources-docs/7112_Access_to_Care_Position_Paper.pdf
5. Moffat SM, Coates DE, Meldrum AM. New Zealand's changing oral health workforce. A dental practitioner's guide to dual-trained dental therapists/dental hygienists. *N Z Dent J.* 2009;105:57-61.
6. Darby ML. The Advanced Dental Hygiene Practitioner at the master's-degree level: is it necessary? *J Dent Hyg.* 2009;83:92-95.
7. Anderson KL, Smith BS. Practicing dental hygienists' perceptions about the bachelor of science in dental hygiene and the oral health practitioner. *J Dent Educ.* 2009;73:1222-1232.
8. Johnson PM. Dental hygiene regulation: a global perspective. *Int J Dent Hyg.* 2008;6:221-228.
9. The benefits of dental hygiene-based oral health provider models. American Dental Hygienists' Association [Internet]. 2013 [cited 2013 Feb 2]. Available from: http://www.adha.org/resources-docs/7116_Benefits_of_Dental_Hygiene.pdf
10. Direct access states. American Dental Hygienists' Association [Internet]. 2014 [cited 2014 April 25]. Available from: https://www.adha.org/resources-docs/7513_Direct_Access_to_Care_from_DH.pdf
11. Limited Access Permit Legislation. Oregon § 680.205 (1997).
12. Issuing Expanded Practice Permits. Oregon § 680.200 (2011).
13. Battrell AM, Gadbury-Amyot CC, Overman PR. A qualitative study of limited access permit dental hygienists in Oregon. *J Dent Educ.* 2008;72:329-343.
14. Bell KP, Coplen AE. Evaluating the impact of expanded practice dental hygienists in Oregon: An outcomes assessment. *J Dent Hyg.* 2015;89(1):17-25.
15. Wing P, Langelier MH, Continelli TA, Battrell A. A dental hygiene professional practice index (DHPPI) and access to oral health status and service use in the United States. *J Dent Hyg.* 2005;79:10.
16. Adams TL. Attitudes to independent dental hygiene practice: dentists and dental hygienists in Ontario. *J Can Dent Assoc.* 2004;70:535-538.
17. Astroth DB, Cross-Poline G. Pilot study of six Colorado dental hygiene independent practices. *J Dent Hyg.* 1998;72:13-22.
18. Kaldenberg DO, Smith JC. The independent practice of dental hygiene: a study of dentists' attitudes. *Gen Dent.* 1990;38:268-271.
19. Edgington E, Pimlott J. Public attitudes of independent dental hygiene practice. *J Dent Hyg.* 2000;74:261-270.
20. Perry DA, Freed JR, Kushman JE. Characteristics of patients seeking care from independent dental hygienist practices. *J Public Health Dent.* 1997;57:76-81.
21. American Dental Association Commission on Dental Accreditation. Accreditation Standards for a Dental Hygiene Education Program. American Dental Association [Internet]. 2013 [cited 2015 March 27]. Available from: <http://www.ada.org/~media/CODA/Files/dh.ashx>

Exploring Preadmission Criteria as Predictors for Dental Hygiene Licensure Examinations Pass Rates

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Introduction

Dental hygiene programs use a variety of admissions criteria in their admissions selection processes. Program admissions review committees identify students capable of successfully completing the dental hygiene program and passing licensure examinations. Admissions committees are often tasked with determining which variables are most likely to impact student success in academic programs. Research specific to dental hygiene admissions is inconsistent and the validity of the criteria used for admissions has not been established.

Grade Point Average (GPA)

Previous academic achievement is a factor used in many allied health programs for admissions. A number of accredited dental hygiene programs consider high school grades in the admissions process. Twenty percent use high school science GPA, 9% use non-science GPA, 9% use overall high school GPA and 12% reported "other" for assessing high school grades. College grades are also considered in dental hygiene admissions.¹ Seventy percent of accredited programs use college science GPA, 45% use non-science GPA, 70% use overall college GPA and 26% reported "other" for assessing college grades.¹ DeAngelis noted positive associations between entering GPA and scores for the National Board Dental Hygiene Examination (NBDHE).² Bauchmoyer et al validated these findings.³ Austin found college GPA was weakly correlated to NBDHE scores.⁴ Alzahrani et al found GPA was not a statistically significant variable when associated with successful outcomes on the NBDHE.⁵ Dental hygiene studies relate conflicting findings as to whether or not GPA is a positive predictor

Abstract

Purpose: Research specific to dental hygiene can provide programs guidance to implement the best admissions practices. This study sought to first identify all admissions variables currently being utilized by dental hygiene programs. Secondly, this study looked for associations between these variables and program pass rates on national and regional clinical board examinations.

Methods: An online survey was sent by email to 309 dental hygiene chairs/program directors. The survey was comprised of 18 questions to collect program demographic information, program admissions requirements, and program pass rates on both the National Board Dental Hygiene Examination (NBDHE) and regional clinical board examinations.

Results: One hundred and thirty-nine respondents participated in the survey for a response rate of 45%. Twenty-nine admissions variables were found and correlated to program clinic pass rates (n=131) and program NBDHE pass rates (n=133). The 2 admissions variables most often used by dental hygiene programs are overall college grade point average (GPA) at 67.6% and college science GPA at 61.2%. Multiple regression analysis detected no statistically significant variables as positive indicators for licensure examination pass rates.

Conclusion: Currently there are no defined variables associated with clinical and national licensure pass rates. Further research is needed to identify variables that are associated with clinical and national licensure pass rates.

Keywords: admissions criteria, dental hygiene, program admissions, performance indicators

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

of NBDHE success. Furthermore, there is currently no dental hygiene research to validate GPA as a predictor of success on clinic licensure board examinations.

Standardized Testing

Along with GPA, standardized testing is used in dental hygiene admissions. Thirty-one percent of accredited dental hygiene programs use the American College Test (ACT), 18% use the Scholastic Achievement Test (SAT) and 46% reported "other"

for test score assessment.⁶ Edenfield and Hansen noted linkages between ACT and SAT with success on the NBDHE.⁶ The reading comprehension component of the ACT has shown potential in predicting NBDHE scores.⁴ Several nursing studies found the SAT and ACT to predict licensure examination scores for nursing students.^{7,8} The predictive ability found in these studies could translate to dental hygiene clinic licensure examination success but has yet to be determined.

A standardized test formally used for admissions to dental hygiene programs was called the Dental Hygiene Aptitude Test (DHAT). The DHAT originated in 1956 and was used as a pre-admission examination for dental hygiene.⁹ The intent of this exam was to measure numerical ability, science knowledge, verbal knowledge, and capability of reading and comprehending scientific information.¹⁰ The DHAT was shown to be a positive predictor for the NBDHE according to a study done by Longenbecker and Wood.¹¹ In addition, this study compared predictive capability of both the DHAT and the ACT indicating the DHAT as the "most valid single predictor of NBDHE scores."¹¹ To the authors' knowledge, there have been no studies related to the DHAT in more than 25 years and none that validate this test as a predictor for clinical licensure examination success.

The purpose of the DHAT is similar to what dental schools use for admissions. The Dental Admission Test (DAT) provides an assessment of academic aptitude and understanding of scientific knowledge. In addition, it provides an assessment of perceptual ability.¹² In a study conducted by Park et al, clinical performance on operative procedures was associated with the biology component of the DAT for students at the Harvard School of Dental Medicine.¹³ Bergman et al reported that the reading comprehension component of the DAT was statistically significant when associated to the NBDE part I.¹⁴ DeBall et al found similar associations between the DAT reading comprehension component and NBDE anatomic science scores.¹⁵ For comprehensive examinations, the quantitative reasoning and total science portions of the DAT were positive predictors of performance.¹⁶ These studies suggest that the DAT is associated with performance on the NBDE possibly demonstrating the predictive validity of the use of standardized testing to foresee candidates' ability to pass licensure examinations during pre-admission selection.

Other standardized tests such as the Allied Health Professions Admission Test (AHPAT) show an ability to predict allied health in-course GPA as well as national certification exams.^{7,17,18} The Health Science

Reasoning Test (HSRT) is used to assess critical thinking skills as part of the admissions process. Scores on the HSRT correlate with both candidate rank and scores on the Pharmacy College Admission Test (PCAT).^{19,20} Another pre-admission test to assess critical thinking skills is the California Critical Thinking Skills Test (CCTST). This test has been positively linked to allied health program success as well as clinical judgment.²¹ Initial dental hygiene clinical performance has been positively linked to the CCTST. Additionally, the CCTST is a predictor of NBDHE scores.^{22,23} Studies have identified the Test of Essential Academic Skills (TEAS) as a predictive tool for nursing program success.^{24,25} Schultz et al found the Health Occupations Basic Entrance Test (HOBET) a better predictor of academic student success in allied health programs compared to the ACT.²⁶ The TEAS and HOBET show predictive ability for several allied health programs, yet only the ACT, SAT, DHAT and CCTST have been linked to dental hygiene academic success. The ACT, AHPAT, CCTST, DHAT, HOBET, HSRT, PCAT, SAT and the TEAS have not been validated as predictors of clinical licensure examination success. Furthermore, the AHPAT, HSRT, TEAS and HOBET assessments have yet to be validated for their ability to predict scores on the NBDHE.

Non-cognitive Variables

Dental hygiene programs also use non-cognitive variables for admissions requirements such as manual dexterity or psychomotor skills testing. Three percent of accredited dental hygiene programs utilize manual dexterity tests.¹ Researchers have explored the Perceptual Abilities Test (PAT) or Part II of the DAT for usefulness in measuring motor skills.²⁷ In a study by Holmes et al, students who passed the clinical board examination demonstrated higher PAT scores than the students who failed the clinical board examination.²⁸ Psychomotor tests predict dental student course grades for Oral Anatomy and Operative Dentistry.²⁹ Tweezers dexterity aptitude has been studied as a predictor of dental student success. In a study by Lundergan et al, the use of tweezers dexterity tests to augment the predictive capability of the PAT is uncertain.³⁰ The Purdue Pegboard Test is used to evaluate motor dexterity among medical students. Students pursuing a surgical field did not have greater dexterity scores than the students pursuing a non-surgical field.³¹ The research is unclear as to the usefulness of assessing motor skill as a predictor for academic and clinical performance. These dexterity tests along with the Crawford Small Parts Dexterity Test, California Performance Test and Perception and Control Test have yet to be correlated with dental hygiene licensure examinations.

Letters of recommendation are used by 26% of accredited dental hygiene programs.¹ There is currently no dental hygiene literature available to validate the use of letters of recommendation in admissions. Pre-admission interviews are used by 35% of accredited dental hygiene programs.¹ Evans and Dirks determined that interview scores were significantly related to laboratory grades.³² Interview scores have still not been correlated to NBDHE and clinical licensure exam scores.

Previous dental office experience is required as part of the dental hygiene admissions process by 46% of accredited dental hygiene programs.¹ Previous dental experience, specifically dental assisting, was positively correlated to dental hygiene clinic performance and clinic GPA in a study done by DeAngelis and Goral.³³ Park et al reported that dental students with prior assisting experience are more apt to obtain higher scores in pre-clinical courses.³⁴ The requirement of dental office experience for admissions has not been confirmed as a predictor for NBDHE or regional clinical licensure examination success.

Although manual dexterity exams, letters of recommendation and interviews are variables used by dental hygiene programs for admissions decisions, there is no dental hygiene literature available to relate these variables to NBDHE and clinic licensure exam scores. This study sought to identify all variables that are currently used by U.S. dental hygiene programs and to explore possible associations between these variables and program pass rates on national and regional clinical licensure board examinations.

Methods and Materials

This quantitative study is both exploratory and descriptive in design. This study was approved by the University of Bridgeport Institutional Review Board. The instrument used for data gathering was a survey developed by the researchers and administered via email. The survey was comprised of 18 questions to collect program demographic information, program admissions requirements, and program pass rates on both the NBDHE and regional clinical board examinations. Readability and validity were determined through a pilot survey reviewed by 5 dental hygiene faculty at various academic institutions. The faculty reported any problems and questions needing clarification to the researchers.

Email addresses for dental hygiene program directors were obtained from the American Dental Hygienists' Association website and 309 directors/chairs from the U.S. were invited to participate. The

email invitation provided directors with a cover letter and a link to the electronic survey hosted by SurveyMonkey. A second request for participation was emailed to program directors 11 days later and the survey was closed 4 days after the second request. Program director email addresses were not linked to survey responses. Survey responses were reviewed for completeness.

Data was entered into SAS version 9.2 (SAS Institute Inc.). Descriptive statistics using measures of central tendency were used as well as inferential statistics using multiple regression analysis. An alpha level of 0.05 was used for statistical testing. Multiple regression analysis was used to look for relationships between the independent variables (dental hygiene admissions criteria) and the dependent variables (NBDHE pass rates/clinical pass rates). For the purposes of this study, NBDHE pass rates are defined as the percentage of candidates per program that pass the NBDHE on the first attempt. Likewise, clinical pass rates are defined as the percentage of candidates per program that pass the clinical licensure board examination on the first attempt.

Results

Of the 309 programs invited to participate, 139 programs chose to participate for a response rate of 45%. Because some of the respondents did not answer each question, the sample size when exploring clinic pass rates was $n=131$ and for national pass rates was $n=133$.

Admissions Variables Currently Utilized

There are many different combinations of GPA variables used for dental hygiene program admissions. Additionally, several types of standardized test assessments were reported as well as numerous non-cognitive variables. The percentages of participating programs that utilize each of the variables can be reviewed in Table I. The type of manual dexterity test utilized by the dental hygiene programs include the California Performance Test, Crawford Small Parts Dexterity Test, Johnson O'Connor Tweezer Dexterity Test, Perception and Control Test, Purdue Manual Dexterity, and a peg board and symbol digit test. The CCTST was reported by 1 participant. This variable was a linear combination of other variables in the model so is not shown in the data set. Additionally, the Wonderlic assessment was reported, however, clinical and national pass rate data was not provided.

Clinical Pass Rates

Participating programs provided the percentage of

Table I: Variable Used by Dental Hygiene Programs for Admissions Decisions

Variable	Mean
Overall College GPA	67.6%
College Science GPA	61.2%
American College Test	30.2%
Pe-Admission Interview	29.5%
Previous Dental Experience	28.1%
Essay	23.7%
Scholastic Aptitude Test	20.9%
Letters of Recommendation	18.7%
High School Science GPA	16.5%
Prerequisite GPA	15.1%
Overall High School GPA	14.4%
Community Service	13.7%
Health Occupations Basic Entrance Test	11.5%
Personal Statement	11.5%
Health Occupations Aptitude Exam/Psychological Services Bureau	7.9%
Compass	6.5%
Test of Essential Academic Skills	6.5%
Accuplacer	5.8%
Spatial Ability	4.3%
General Education Requirements	3.6%
Manual Dexterity Tests	3.6%
Personality Assessment	3.6%
Allied Health Professions Admissions Test	2.2%
National League for Nursing Preadmission Examination	2.2%
Asset	1.4%
Health Science Reasoning Test	1.4%
Texas Assessment	1.4%
Wonderlic	1.4%
California Critical Thinking Skills Test	0.7%

their eligible candidates that passed the clinical licensure examination on the first attempt. The mean for program clinical pass rates was 91.8%. Multiple regression analysis found no statistically significant independent variables ($p < 0.05$). Table II shows the results of multiple regression analysis for clinical pass rates for each of the admissions criteria provided by dental hygiene programs.

NBDHE Pass Rates

Participating programs provided the percentage of their eligible candidates that passed the NBDHE on the first attempt. The mean for national board pass

Table II: Multiple Regression Analysis for Clinical Pass Rates

Admissions Variable	Estimate	tValue	Pr> t
Intercept	89.5%	24.76	<0.0001
Essay	-6.8%	-1.81	0.074
Health Occupations Aptitude Exam (Psychological Services Bureau)	-10.6%	-1.75	0.084
Preadmission Interview	6.0%	1.68	0.096
Manual Dexterity Tests	-15.2%	-1.34	0.183
Previous Dental Office Experience	-3.8%	-1.19	0.236
National League for Nursing Preadmission Examination	9.1%	1.16	0.249
Prerequisite GPA	-3.8%	-1.01	0.314
Allied Health Professions Admission Test	8.5%	1.01	0.316
Test of Essential Academic Skills	4.6%	0.94	0.35
College Science GPA	2.4%	0.89	0.376
Spatial Ability	12.4%	0.86	0.389
Personal Statement	4.2%	0.86	0.392
High School Science GPA	3.1%	0.79	0.429
American College Test	2.3%	0.68	0.495
Health Science Reasoning Test	5.3%	0.55	0.581
Asset	-5.4%	-0.5	0.615
Compass	2.5%	0.47	0.643
Scholastic Aptitude Test	1.4%	0.38	0.701
Accuplacer	-1.9%	-0.36	0.717
Personality Assessment	3.5%	0.19	0.852
General Education Requirements	1.3%	0.17	0.868
Community Service	0.8%	0.16	0.875
Texas Assessment	-1.0%	-0.1	0.919
Letters of Recommendation	0.4%	0.09	0.931
Overall College GPA	-0.3%	-0.08	0.933
Health Occupations Basic Entrance Test	-0.3%	-0.07	0.944
Overall High School Science GPA	0.0%	0	0.997

rates was 96.8%. The independent variables were correlated to NBDHE pass rates using multiple regression analysis. Of these variables analyzed, none emerged as statistically significant criteria. Table III shows the results of multiple regression analysis for NBDHE pass rates for each of the admissions criteria provided by dental hygiene programs.

Discussion

The first objective of this study was to identify all variables currently utilized by dental hygiene programs. The admissions variables identified in this study and the corresponding mean for these factors is displayed in Table I. Some of these variables collected are not made available as a response choice in the yearly American Dental Association's Survey of Dental Hygiene Education Programs. This fact may account for selection of "other" categories in the survey.¹

The second objective of this study was to explore possible associations between the identified admissions variables and pass rates on licensure examinations. The 3 categories of independent variables that were explored in this study are GPA, standardized testing and non-cognitive variables used in program admissions. Pre-requisite GPA was reported by 15.1% of participating programs and general education requirements were reported by 3.6%. These GPA admission factors, in addition to overall college, college science, overall high school and high school science averages, were not identified in this study as statistically significant variables. This data supports the study done by Alzahrani et al reporting that there is no statistically significant relationship between incoming GPA and NBDHE success.⁵

Standardized tests were explored as potential preadmission predictors for licensure examination success. The sample size used for analysis of the ACT (30.2%) for this study was comparable to the percentages reported in the Survey of Dental Hygiene Education Programs (31%).¹ The ACT did not emerge as a statistically significant variable. This data fails to corroborate findings of Edenfield and Hansen, which noted linkages between the ACT and the NBDHE.⁶

As for non-cognitive variables, less than 2% of participating programs reported using manual dexterity tests for admissions. This small sample size is consistent with the Survey of Dental Hygiene Education Programs where 3% of accredited dental hygiene programs reported using this criterion.¹ The analysis of this variable showed no relationship to pass rates. The use of letters of recommendation was not statistically significant as related to licensure examination pass rates. As there are no other dental hygiene studies to validate these findings, additional research in this area must be considered. Although Evans and Dirks found a positive relationship between laboratory grades and interview scores, those findings did not translate to this national study.³² While interviews were not found to be statistically significant in this study, the use of a

Table III: Multiple Regression Analysis for NBDHE Pass Rates

Admissions Variable	Estimate	tValue	Pr> t
Intercept	96.30%	56.39	<.001
Accuplacer	-4.73%	-1.88	0.063
National League for Nursing Preadmission Examination	-4.65%	-1.25	0.214
Prerequisite GPA	2.01%	1.15	0.255
Compass	2.70%	1.05	0.296
Essay	1.71%	0.96	0.337
College Science GPA	1.19%	0.96	0.341
Health Occupations Aptitude Exam (Psychological Services Bureau)	-2.61%	-0.91	0.366
Preadmission Interview	1.41%	0.84	0.402
Letters of Recommendation	-1.53%	-0.69	0.493
American College Test	-0.96%	-0.61	0.541
Overall College GPA	-0.90%	-0.60	0.548
Personal Statement	1.31%	0.56	0.577
Overall High School Science GPA	0.85%	0.44	0.663
Health Science Reasoning Test	1.89%	0.42	0.677
Spatial Ability	2.57%	0.38	0.705
Community Service	-0.86%	-0.37	0.715
Scholastic Aptitude Test	0.55%	0.31	0.759
Asset	-1.23%	-0.24	0.808
Texas Assessment	1.13%	0.24	0.814
Personality Assessment	-1.71%	-0.19	0.848
High School Science GPA	-0.33%	-0.18	0.856
Manual Dexterity Test	0.89%	0.17	0.868
Allied Health Professions Admission Test	-0.49%	-0.12	0.902
General Education Requirements	-0.38%	-0.10	0.918
Health Occupations Basic Entrance Test	-0.20%	-0.10	0.921
Previous Dental Experience	-0.08%	-0.05	0.960
Test of Essential Academic Skills	0.00%	0.00	0.999

standardized interview for admissions needs to be investigated. Research supports the use of a standardized or structured interview for medical admission selection criteria.^{35,36}

Another non-cognitive variable is the use of previ-

ous dental experience. DeAngelis and Goral showed a positive correlation between previous dental assisting experience and dental hygiene clinic performance, as well as clinic GPA.³³ This study did not validate those findings possibly due to the low response rate of this category by participating programs. The Survey of Dental Hygiene Education Programs established that 46% of accredited dental hygiene programs use previous dental experience as an admissions criterion.¹ In this study, only 28.1% of participating programs reported using previous dental office experience. It is possible that many of the non-participating programs utilize this admissions factor thereby affecting the response rate for this particular variable.

The data collected from the survey revealed a multifaceted approach to requirements for dental hygiene program admissions. Programs reported using a variety of combinations of GPA as well as numerous standardized test assessments and a number of non-cognitive variables. The current study found none of these variables to be positively correlated to program pass rates on the NBDHE. Additionally, none of the admissions criteria were statistically significant for predicting program pass rates on clinical licensure board exams.

The dental hygiene profession requires the same motor skills needed in dentistry. The profession could contemplate using an admissions exam similar to the DAT. Historically, there existed a DHAT available for dental hygiene admissions. Dental hygiene studies have inferred that the DHAT has greater predictive power over the ACT and SAT to determine NBDHE success as well as dental hygiene clinical and didactic grades.⁹⁻¹¹ The authors suggest consideration of the development of an admissions test specific to dental hygiene.

Data collected from this national dental hygiene survey showed a lack of standardization for admissions criteria required by dental hygiene programs. The question to be raised is do the multi-dimensional, varying criteria being utilized for dental hygiene program admissions lend itself to the inability to establish valid predictors of dental hygiene success? Additional research correlating combinations of these variables could lead to finding an evidence-based strategy for the admissions selection process. Further research to confirm a basic dental hygiene admissions platform is still warranted.

Moreover, the authors propose that the theoretical implications of this study include consideration to a different view on admissions procedures. The literature review shows conflicting results on best admissions practices. This study failed to identify

any statistically significant preadmission predictors for success on dental hygiene licensure examinations. Theoretically, candidates with certain attributes along with expert faculty instruction could yield successful outcomes. Consideration must be given to the possibility that a student's basic aptitude for learning clinical skills may not be a necessary factor during the admissions selection process. However, further investigation to discover measures that can assess clinical ability prior to admittance may be warranted.

While admissions and demographic data were collected in this study, future studies should narrow the investigation to specific categories of admissions variables. A limitation of this study is that self-reported data has the potential to be skewed and biased by participants. Another limitation of this study is that it is uncertain as to what types of variables the non-participating dental hygiene programs are currently using. It is conceivable that an undiscovered admissions factor exists that can be positively linked to program licensure examination pass rates. Further research to investigate the multiple combinations of GPA, standardized test assessments and non-cognitive variables for admissions is suggested. As this study investigated program pass rates, it is also recommended that research be initiated that explores the relationship of these variables to individual scores.

Conclusion

This study explored factors used in dental hygiene admissions that can be further investigated to determine their validity and reliability. In addition, this study demonstrates the need for the development of new dental hygiene program admissions standards. This study suggests that a foundation for reliable, valid and evidence-based dental hygiene program admissions standards still needs to be developed.

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References

1. American Dental Association. 2012-13 Survey of Dental Hygiene Education Programs. American Dental Association [Internet]. 2014 [cited 2015 March 27]. Available from: http://www.ada.org/~media/ADA/Science%20and%20Research/HPI/Files/SALL-DH_2011-12_and_2012-13_final20150107t173800.ashx
2. DeAngelis S. Noncognitive predictors of academic performance. Going beyond the traditional measures. *J Allied Health*. 2003;32(1):52-57.
3. Bauchmoyer SM, Carr MP, Clutter JE, Hoberty PD. Predicting academic and National Board Dental Hygiene Examination performance based on academic factors. *J Dent Hyg*. 2004;78(1):39-45.
4. Austin LD. Predicting National Dental Hygiene Board Examination success based on specific admission factors. *J Dent Hyg*. 2011;85(4):335-339.
5. Alzahrani MJ, Thomson EM, Bauman DB. Predictors of student success in an entry-level baccalaureate dental hygiene program. *J Dent Hyg*. 2007;81(2):51.
6. Edenfield SM, Hansen JR. Relationships among dental hygiene course grades, a mock board dental hygiene examination, and the National Board Dental Hygiene Examination. *J Dent Hyg*. 2000;74(2):124-129.
7. Salvatori P. Reliability and validity of admissions tools used to select students for the health professions. *Adv Health Sci Educ Theory Pract*. 2001;6(2):159-175.
8. Grossbach A, Kuncel NR. The predictive validity of nursing admission measures for performance on the National Council Licensure Examination: a meta-analysis. *J Prof Nurs*. 2011;27(2):124-128.
9. Hodge GT. The dental hygiene aptitude test: controversy in testing. *Educ Dir Dent Aux*. 1980;5(3):9-10.
10. Rudman W. DHAT Dental Hygiene Aptitude Test. Admission Test Series. New York: National Learning Corporation; 2010.
11. Longenbecker SW, Wood PH. The Dental Hygiene Aptitude Tests and the American College Testing Program tests as predictors of scores on the National Board Dental Hygiene Examination. *Educ Psych Measurement*. 1984;44(2):491-495.
12. Kingsley K, Sewell J, Ditmyer M, et al. Creating an evidence-based admissions formula for a new dental school: University of Nevada, Las Vegas, School of Dental Medicine. *J Dent Educ*. 2007;71(4):492-500.
13. Park SE, Susarla SM, Massey W. Do admissions data and NBDE Part I scores predict clinical performance among dental students? *J Dent Educ*. 2006;70(5):518-524.
14. Bergman AV, Susarla SM, Howell TH, Karimbux NY. Dental Admission Test scores and performance on NBDE Part I, revisited. *J Dent Educ*. 2006;70(3):258-262.
15. De Ball S, Sullivan K, Horine J, et al. The relationship of performance on the dental admission test and performance on Part I of the National Board Dental Examinations. *J Dent Educ*. 2002;66(4):478-484.
16. Allareddy V, Howell TH, Karimbux NY. Association between students' dental admission test scores and performance on comprehensive clinical exams. *J Dent Educ*. 2012;76(2):168-173.
17. Goodyear N, Lampe MF. Standardized test scores as an admission requirement. *Clin Lab Sci*. 2004;17(1):19-24.
18. Balogun JA. Predictors of academic and clinical performance in a baccalaureate physical therapy program. *Phys Ther*. 1988;68(2):238-242.
19. Kelsch MP, Friesner DL. The health sciences reasoning test in the pharmacy admissions process. *Am J Pharm Educ*. 2014;78(1):9.
20. Cox WC, Persky A, Blalock SJ. Correlation of the Health Sciences Reasoning Test with student admission variables. *Am J Pharm Educ*. 2013;77(6):118.

21. Allen DD, Bond CA. Prepharmacy predictors of success in pharmacy school: grade point averages, pharmacy college admissions test, communication abilities, and critical thinking skills. *Pharmacotherapy*. 2001;21(7):842-849.
22. Williams KB, Schmidt C, Tilliss TS, et al. Predictive validity of critical thinking skills and disposition for the national board dental hygiene examination: a preliminary investigation. *J Dent Educ*. 2006;70(5):536-544.
23. Williams KB, Glasnapp DR, Tilliss TS, et al. Predictive validity of critical thinking skills for initial clinical dental hygiene performance. *J Dent Educ*. 2003;67(11):1180-1192.
24. McCarthy MA, Harris D, Tracz S. Academic and nursing aptitude and the NCLEX-RN in baccalaureate programs. *J Nurs Educ*. 2014;53(3):151-160.
25. Wolkowitz AA, Kelley JA. Academic predictors of success in a nursing program. *J Nurs Educ*. 2010;49(9):498-503.
26. Schultz B, Rakow EA. A validity study comparing the ACT and the HOBET entrance examinations for health-care students. Paper presented at the Annual Meeting of the Mid-South Educational Research Association. Point Clear, AL. November 17-19. 1999.
27. Gansky SA, Pritchard H, Kahl E, et al. Reliability and validity of a manual dexterity test to predict preclinical grades. *J Dent Educ*. 2004;68(9):985-994.
28. Holmes DC, Doering JV, Spector M. Associations among predental credentials and measures of dental school achievement. *J Dent Educ*. 2008;72(2):142-152.
29. Ackerman PL, Cianciolo AT, Bowen KR. Improving selection for psychomotor skills in dentistry. Proceedings of the Human Factors and Ergonomics Society 43rd Annual Meeting. 898-902.
30. Lundergan WP, Soderstrom EJ, Chambers DW. Tweezer dexterity aptitude of dental students. *J Dent Educ*. 2007;71(8):1090-1097.
31. Lee JY, Kerbl DC, McDougall EM, Mucksavage P. Medical students pursuing surgical fields have no greater innate motor dexterity than those pursuing nonsurgical fields. *J Surg Educ*. 2012;69(3):360-363.
32. Evans JG, Dirks SJ. Relationships of admissions data and measurements of psychological constructs with psychomotor performance of dental technology students. *J Dent Educ*. 2001;65(9):874-882.
33. DeAngelis S, Goral V. Dental assisting experience as a predictor of dental hygiene academic performance. *J Dent Hyg*. 1995;69(4):169-173.
34. Park SE, Da Silva JD, Barnes JL, et al. Predicting dental school performance based on prior dental experience and exposure. *Eur J Dent Educ*. 2010;14(1):1-6.
35. Bandiera G, Regehr G. Reliability of a structured interview scoring instrument for a Canadian postgraduate emergency medicine training program. *Acad Emerg Med*. 2004;11(1):27-32.
36. Patrick LE, Altmaier EM, Kuperman S, Ugolini K. A structured interview for medical school admission, Phase 1: initial procedures and results. *Acad Med*. 2001;76(1):66-71.

Assessment of Pathology Instruction in U.S. Dental Hygiene Educational Programs

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Introduction

Medically compromised patients are individuals disabled from systemic diseases or conditions arising from aging, obesity, new infections and use and abuse of drugs.¹ These pathologic conditions can be associated with oral health problems. The needs of these individuals for oral health care are not being met due to their limited access to oral health care professionals. The Surgeon General's Report, National Oral Health Call to Action, reported the disparities in the nation's health delivery system, stating that it will take all health care professionals working together to promote oral health of our nation.² Dental hygienists are licensed preventive oral health professionals who have the potential to meet the needs of this medically compromised population. However, it is not known whether or not they are adequately prepared for this role.

According to the National Dental Hygiene Research Agenda, studies are needed to evaluate the extent to which current entry-level dental hygiene curricula prepare dental hygienists to meet the increasingly complex oral health care needs of the public.^{3,4} Instruction in pathology content areas help prepare students for this role. It has been stated that the knowledge gained from pathology instruction enables students to understand and participate comprehensively in the delivery of health care.⁵

The Commission on Dental Accreditation (CODA) Standards for Dental Hygiene Education specifies that pathology clock hours (i.e., classroom time) be classified in terms of general pathology and oral

Abstract

Purpose: To assess the instruction of pathology content in entry-level and advanced practitioner dental hygiene educational programs and the program directors' perceptions whether their graduates are adequately prepared to meet the increasingly complex medical and oral health needs of the public.

Methods: A 28-question survey of instructional content and perceptions was developed and distributed using Qualtrics® software to the 340 directors of entry-level and advanced practitioner dental hygiene programs in the US. Respondents rated their level of agreement to a series of statements regarding their perceptions of graduates' preparation to perform particular dental hygiene services associated with pathology. Descriptive statistics for all 28 categorical survey questions were calculated and presented as the frequency (percentage).

Results: Of the 340 directors surveyed, 130 (38%) responded. Most entry-level respondents (53%) agreed or strongly agreed (29%) that their graduates were adequately prepared to meet the complex medical and oral health needs of the public, while all respondents of advanced practitioner programs strongly agreed. More respondents strongly agreed to statements related to clinical instruction than to didactic courses. While 64% of respondents agreed that their graduates were prepared to practice unsupervised, if it were legally allowed, 21% were ambivalent. The extent of pathology instruction in entry-level programs varied, but most used traditional formats of instruction, educational resources and assessments of educational outcomes. Advanced practitioner programs emphasized histological and clinical examination of oral lesions and patient case studies.

Conclusion: Strengthening pathology instruction would ensure that future generations of dental hygienists would be adequately prepared to treat medically compromised patients.

Keywords: dental hygiene students, dental hygiene curriculum, dental hygiene programs, oral pathology, oral cancer, medically compromised patients

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.

pathology.⁶ By definition, general pathology content area focuses on "the nature of diseases, its causes, its processes, and its effects, together with associated alterations of structure and function,"

while content in oral pathology is devoted to “the etiology, pathogenesis, identification, and management of diseases, which affect the oral and maxillofacial regions.”⁵ Systemic pathology, the branch of pathology that is concerned with the “etiologies, pathogenesis, and the host response specific to a particular organ system,”⁷ is not specifically listed as a content area in the CODA documents and is often covered in general pathology courses. Clinical courses reinforce these concepts and apply them to clinical situations.

Assessment of general and oral pathology instruction in the entry-level dental hygiene programs has not been reported in terms of instructional content. It is not known whether the instruction in systemic and oral diseases and their treatment has evolved to the extent that students are prepared to treat the medically compromised population. It is known that one study of dental hygienists’ knowledge, opinions and practices, related to oral and pharyngeal cancer risk assessment, demonstrated that 74% of those surveyed believed that they were adequately trained to provide oral cancer examinations, yet only 16% correctly identified 11 out of the 14 risk factors for oral cancer.⁸ That study indicated that current instruction in oral pathology may not be adequately preparing the dental hygienist to conduct oral cancer risk assessments.

Entry-level programs may benefit from studying the curricula of advanced practitioner dental hygiene programs: the California Registered Dental Hygienist in Alternative Practice (RDHAP) program^{9,10} and the Minnesota Advanced Dental Therapist (MSADT) program.^{11,12} Both types of advanced practitioner programs require completion of an entry-level dental hygiene program and a baccalaureate degree or its equivalence for admittance. These programs emphasize educating dental hygienists to effectively and safely provide care to populations disenfranchised by the current system of dental care delivery, while practicing unsupervised.^{9,11-14} These underserved populations are likely to have complex health histories and suffer chronic medical and dental conditions; therefore, extensive preparation in pathology to recognize risk factors for systemic diseases and oral manifestations of systemic disease is required.

The purpose of this study was to assess the instruction of pathology content in entry-level and advanced practitioner dental hygiene educational programs and the perceptions of program directors whether their graduates are adequately prepared to meet the increasingly complex medical and oral health needs of the public.

Methods and Materials

This cross-sectional study was approved by the University of California, San Francisco (UCSF) Institutional Review Board. All directors of the U.S. dental hygiene programs were selected (337 CODA-approved entry-level programs in the U.S., the Metropolitan State University MSADT Program and 2 California RDHAP Programs). Program directors were selected because the authors expected that they would have a comprehensive understanding of both the didactic and clinical aspects of the curriculum. The program directors’ email addresses were obtained from the American Dental Hygienists’ Association (ADHA) or the program’s website.

The survey questionnaire consisted of 28 closed-ended questions in the following domains: curriculum including clock and credit hours, educational format, educational resources, and assessments of educational outcomes, and instructor qualifications (12 multiple-choice questions); perceptions of general and oral pathology instruction preparing students for particular dental hygiene services (11 Likert-like statements); and demographic information about the program (5 multiple-choice questions).

The questionnaire items were pre-tested by 3 experienced dental hygiene educators: 1 who was teaching in a community college program and 2 who were teaching or had taught in a university dental school/baccalaureate program and a community college/associate degree program. They answered each survey item and provided feedback on the clarity of the questions and the amount of time spent to complete the questionnaire. Revisions based upon the educators’ input were incorporated into the final survey questionnaire.

The study was implemented using the UCSF online survey software program, Qualtrics®. A cover letter was sent to the dental hygiene program directors’ email addresses, stating the purpose of the study. The “UCSF Consent to be in Research” form was also sent for the participants to keep for their records. Informed consent was implied with the completed return of the survey. Identification numbers were used to ensure subject confidentiality, while permitting follow-up of non-respondents. Two follow-up letters were sent via Qualtrics® to participants who did not respond to the first request.

Respondents refer to program directors or representatives who completed the survey. Respondents rated their level of agreement to a series of statements regarding their perceptions of whether

current instruction in general and/or oral pathology has adequately prepared their students for particular dental hygiene services. Descriptive statistics for all 28 categorical survey questions were calculated, using SAS version 9.3 (SAS Institute, Cary, NC) and are presented as the frequency (percentage).

Results

Of the 340 survey questionnaires sent to dental hygiene program directors, 130 (38%) were completed. All 3 directors of the advanced practitioner programs (2 RDHAP and 1 MSADT) responded.

Demographic Characteristics of Institutions

The institutional settings of the respondents in the entry-level dental hygiene programs represented 4 different types of institutions known to sponsor dental hygiene programs, with the most common type (57%) being in a public or community college (Table I). Most (76%) of the institutions awarded an associate degree (Table II).

Curriculum of Entry-level Dental Hygiene Programs

General and oral pathology content is presented in entry-level programs in either 1 course, including both general and oral pathology, or in 2 separate courses. Most of the entry-level programs (83%) combine the content into one 3-credit hour course. In the majority of programs (75%) in which there are 2 separate courses, general pathology was allotted 1 to 2 credit hours, and oral pathology allotted 2 credit hours. While the majority of entry-level programs (68%) dedicated 15 to 29 hours to general pathology, the dedicated clock hours for oral pathology had a broader distribution, with the highest percentage (40%) of programs in the 30 to 44 clock hour range (Table III).

Class sessions in the entry-level programs consisted of lectures (100% of respondents), and most programs (80%) included class discussions of case studies. Many other types of educational formats were utilized: student presentations (47%), small group discussions (36%), video and DVD media (29%), and clinical demonstrations (21%). The educational resources used in the educational process for pathology content relied mostly on textbooks, especially those written for dental hygiene students (Table IV). Many programs supplemented instruction with clinical images of lesions, patient case studies and histological/microscopic images of lesions. In most programs, educational outcomes were assessed by written exams (78%) and

Table I: Distribution of Institutional Settings of the Entry-Level Dental Hygiene Programs

Institutional Setting	Number of Respondents (Percent) n=126
Vocational or technical	20 (16%)
Public or community college	72 (57%)
University, not associated with a dental school	20 (16%)
University, associated with a dental school	14 (11%)

Table II: Distribution of Types of Degrees/Certificates Granted By Institutions Sponsoring the Entry-Level Programs

Type of Degrees	Number of Respondents (Percent) n=123
Associate Degree	96 (76%)
Bachelor's Degree	22 (17%)
Certificate in Dental Hygiene	5 (4%)

written exams including identification of pathological images (78%), and evaluation of case studies (58%).

A dental hygienist with training in pathology was the most frequent qualification (27%) of the educator who provided the majority of the pathology instruction in the entry-level programs. Other frequently cited providers included dental hygienists (20%), general dentists (19%) and dentists with training in pathology (20%). The most prevalent setting for instruction in conducting oral cancer risk assessments in the entry-level programs was the clinical courses (83%). Preparation for oral cancer risk assessment was also included in the oral pathology course, according to a high percentage (72%) of respondents.

Perceptions of Entry-level Dental Hygiene Program Directors

Respondents rated their level of agreement to a series of statements regarding their perceptions of whether current instruction in general and/or oral pathology adequately prepared their students for particular dental hygiene services (Table V). The statements related to students' preparation from instruction in general pathology (i.e. recognizing risk factors for systemic diseases and oral manifestations of systemic diseases) elicited agree as

the most frequent response, while most respondents selected strongly agree to the statement of students' being adequately prepared to identify risk factors for oral cancer. The majority of respondents selected comparable percentages of agree and strongly agree to statements

probing risk factors when conducting health history, counseling patients on reducing exposure to oral cancer risk factors and identifying oral lesions. Strongly agree was the overwhelming choice for 2 questions related to clinical instruction (i.e., performing a comprehensive intraoral and extraoral examination, including the palpation of lymph nodes, and feeling comfortable with performing the exam). The greatest percentage of ambivalent responses (21%, neither agree nor disagree) was related to the statement whether graduates were prepared to practice unsupervised, if it were legally allowed. Throughout the survey there was a small percentage of respondents (5%) who selected strongly disagree to each statement.

The most critical statement assessed in this study was whether graduates are adequately prepared to meet the complex medical and oral health needs of the public. Twenty-nine percent of the respondents strongly agreed and 53% agreed, for a total of 82%. The corollary statement of respondents' feeling confident about the students' preparation elicited responses of agreed (27%) and strongly agreed (58%) for a total of 85%.

Advanced Practitioner Programs in Dental Hygiene

All 3 advanced practitioner programs offer general and oral pathology content in their curriculum. The 2 RDHAP programs use an online format, supplemented by limited classroom instruction and weekend seminars,^{9,10} whereas the MSADT program is a full-time graduate program that utilizes classroom-based, web-enhanced, and clinical learning environments.¹¹ While the programs differ in format, all used the same educational resources: audio-visual materials, histological images of lesions, clinical images of lesions and patient case studies. Accordingly, identification of pathological images and evaluation of case studies were used to assess educational outcomes. One program also used the Objective Structured Clinical Examination (OSCE), which uses a variety of written and com-

Table III: Distribution of Didactic Clock Hours (i.e. Classroom Time) In the Entry-Level Programs of the Respondents of General Pathology and Oral Pathology Content Area (n=125)

	Didactic Clock Hours (h) n (Percent)				
	15 to 29 h	30 to 44 h	45 to 59 h	60 to 74 h	>75 h
General Pathology n=125	85 (68%)	20 (16%)	15 (12%)	4 (3%)	1 (1%)
Oral Pathology n=125	45 (36%)	50 (40%)	25 (20%)	3 (2%)	2 (2%)

Table IV: Educational Resources Used In the Educational Process by the Entry-Level Programs

Educational Resource	Number of Respondents (Percent) n=126
Audio-visual materials	71 (56%)
Textbook	120 (95%)
Websites	43 (34%)
Evidence-based research articles	68 (54%)
Histological images of lesions	79 (63%)
Clinical images of lesions	111 (88%)
Patient case studies	100 (79%)

puter based techniques.¹⁵ The pathology instructors in advanced practitioner programs had all been educated at the doctorate level: a general dentist, a dentist with training in pathology and a scientist with background in pathology. Students received instruction in conducting oral cancer risk assessments in clinical and oral pathology courses. One program included oral cancer risk assessments in a course, titled "Health Assessment and Oral Diagnosis Reasoning." All advanced practitioner respondents selected strongly agree to whether their graduates are adequately prepared to meet the increasingly complex medical and oral health needs of the public. Of the rest of the statements regarding perceptions that current instruction prepares graduates for particular dental hygiene services, all but one of the respondents selected strongly agree. The exception was that one respondent simply agreed to the statement regarding the students' preparation to practice unsupervised.

Discussion

This study assessed pathology instruction in dental hygiene programs from 2 different perspectives: examining the instruction of pathology con-

Table V: Perceptions of the Respondents From Entry-Level Dental Hygiene Programs

Statement (n=number of respondents)	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
The current instruction in general pathology adequately prepares our graduates to recognize risk factors for systemic diseases (n=126)	32%	48%	12%	3%	5%
The current instruction in general and oral pathology adequately prepares our graduates to recognize oral manifestations of systemic disease (n=125)	39%	52%	3%	1%	5%
The current instruction in oral pathology adequately prepares our graduates to identify risk factors for oral cancer (n=126)	60%	33%	2%	0%	5%
The current instruction in oral pathology adequately prepares our graduates to probe these risk factors when conducting a health history (n=125)	42%	46%	8%	0%	4%
The current instruction in oral pathology adequately prepares our graduates to counsel patients on reducing exposure to oral cancer risk factors (n=124)	45%	41%	8%	2%	4%
The current clinical instruction adequately prepares our graduates to perform a comprehensive intraoral and extraoral examination, including the palpation of lymph nodes (n=124)	65%	27%	3%	0%	5%
The current clinical experiences adequately prepare our graduates to feel comfortable performing a comprehensive intraoral and extraoral examination (n=125)	70%	24%	2%	0%	5%
The current didactic and clinical instruction in oral pathology adequately prepares our graduates to identify oral lesions (n=126)	44%	48%	3%	2%	4%
The current instruction in general and oral pathology adequately prepares our graduates to meet the complex medical and oral need of the public (n=126)	29%	53%	10%	5%	4%
The current instruction in general and oral pathology adequately prepares our graduates to practice independently, if legally allowed (n=126)	22%	42%	21%	10%	5%

tent and surveying directors of both entry-level and advanced practitioner programs as to their perceptions of their graduates' preparation to perform particular dental hygiene services. Results indicated that 29% of respondents from entry-level programs strongly agreed and 53% agreed that their graduates were adequately prepared to meet the complex medical and oral health needs of the public. All respondents of advanced practitioner programs strongly agreed that their graduates were adequately prepared for that role.

The curricula of entry-level programs varied as to the extent of general and oral pathology instruction. This is not surprising as CODA does not dictate specific credit hours, clock hours or format of instruction to meet accreditation standards. Their

requirements are general and currently allow considerable flexibility and latitude in structuring and implementing educational curricula and assessing outcomes of the educational process. While this philosophy has stimulated curricular innovation, with excellent academic results, some programs may have benefitted from more stringent requirements from CODA.

Combining general and oral pathology into 1 course, often also covering systemic pathology content, seems popular. The general pathology content includes basic pathologic processes, such as inflammation, infection and immunity, and the application of these processes to specific organ systems. These applications are often considered to be systemic pathology. A strong background in

general and systemic pathology is essential to be adequately prepared to recognize risk factors for systemic diseases and oral manifestations of systemic diseases. Multiple studies have shown the link between periodontitis and systemic diseases, such as diabetes and cardiovascular disease. However, this relationship between periodontal disease and systemic disease is complex and requires a fundamental knowledge of pathological mechanisms.¹⁶

The emphasis of programs on oral pathological conditions is evident in the number of clock hours of oral pathology content. Accordingly, more respondents agreed that their students were adequately prepared in the dental hygiene services, which are based on oral pathology content. This content may be more directly related to clinical dental hygiene, such as identifying oral lesions. Oral cancer, its common oral sites and risk factors, is a substantial part of oral pathology. These concepts are also taught in the initial dental hygiene clinical course, where students learn how to conduct comprehensive extraoral and intraoral examinations.

Instruction in conducting oral cancer risk assessments occurred in both the oral pathology course and in the lecture and clinical components of the clinical courses. Most respondents agreed that their students are adequately prepared to identify risk factors for oral cancer. Adequate preparation in this service may be overly optimistic, considering the results of one study of graduate dental hygienists, which demonstrated that only 16% correctly identified 11 out of 14 risk factors.⁸ Generally, respondents agreed more positively about the preparation of their graduates in clinical experiences than in didactic material. Because in this study the majority of pathology instructors were dental hygienists with training in pathology, perhaps there is greater emphasis on clinical aspects of pathology instruction. Clinical procedures, such as intraoral and extraoral examination and medical history, are repeated with each clinic patient, so the high percentage of adequate preparation for these procedures is not surprising. On the other hand, only 74% of graduate dental hygienists in the previously mentioned study responded that they were adequately trained to provide oral cancer examinations.⁸ That study differed from the current study, in that it surveyed dental hygienists as to their preparation, while the current study questioned program directors as to their perceptions of the preparation of their graduates.

Graduating dental students have been surveyed as to their perceptions of their oral cancer education. In one study the students perceived a lack of requisite knowledge and skills, which would be

necessary to incorporate oral cancer detection procedures into their oral health care delivery.¹⁷ In a similar study dental students perceived that they were not adequately trained to perform biopsies or to interpret pathology reports, although they felt comfortable performing the oral cancer examination.¹⁸ Dental students, as well as dentists, have been assessed as to their knowledge of common sites for oral cancer. As examples, only 55% of students at one dental school knew the most common sites for oral cancer,¹⁹ and only approximately half the dentists in a nation-wide survey knew the 2 most common intraoral sites of cancer.²⁰ This leads one to speculate as to what factors are important in improving comprehension and retention of pathology instruction.

In the current study, the format of didactic instruction in the pathology courses included the traditional modes of lectures, but with a greater emphasis on new technology. Lecture was the most commonly utilized instructional format in the responding dental hygiene programs with a variety of other useful adjunct educational tools incorporated into the curriculum (e.g. YouTube, student-led discussions and online weekly activities.) Several research studies have probed the effectiveness of various educational models. Digital teaching elements were reported to enhance student learning using pen-technology, YouTube, and virtual conferencing in organic and biochemistry courses, as well as using virtual microscopy to study pathological images.^{21,22} Medical students' retention rates of instructional material improved with the use of interactive software and multimedia tutorials, as compared to lecture format.^{23,24} Multimedia instruction in health professions education is equal or more effective than traditional instruction for attainment of knowledge, skill and performance, as evidenced by a literature review.²⁵

The curricula of all 3 advanced practitioner programs use audio-visual materials and histological and clinical images of lesions, emphasizing the importance of being able to recognize, as well as understand, the underlying mechanisms of pathological lesions. Patient case studies were another popular educational resource. Studying these case studies provides excellent opportunities for the students to apply their knowledge of general, systemic and oral pathology to hypothetical patients, as well as to practice making decisions as how best to treat their future patients, who may have complex medical and dental needs. Utilized more fully, these educational resources would strengthen the pathology instruction in the entry-level programs.

Students from some entry-level programs may

not be prepared, as evidenced by 5% of the respondents that strongly disagreed with each of the perception statements. One can only speculate as to the reasons creating these negative evaluations of the pathology instruction at the respondents' institutions. There could be budgetary problems or difficulty in recruiting a qualified, conscientious pathology instructor. Perhaps the students are entering the program without an adequate scientific background to be able to comprehend pathologic concepts. Programs in educational settings that limit their length are said to struggle to incorporate new content and technology into their overcrowded curriculum.²⁶ Examining the curricula of the advanced practitioner programs may provide examples to offer ideas for strengthening the pathology curriculum at these institutions.

The advanced practitioner programs were developed to help serve the underserved population and improve access to care. Furthermore, Mertz and colleagues confirmed that RDHAP practices were successfully "improving access to care, particularly for minority, medically compromised and disabled populations."²⁷ Both types of advanced practitioner have been able to meet the needs of this population because they are legally able to practice unsupervised in residential care facilities, public health clinics and with homebound patients. In the current study, the statement whether graduates are prepared to practice unsupervised, if it were legally allowed, elicited many undecided responses. This may indicate that the directors of entry-level programs have not formulated their opinions on this controversial issue. Perhaps they are not aware of what unsupervised practice entails, so they could not evaluate the students' preparation for it. Unsupervised can have multiple meanings, often based upon the scope of practice of individual states. Direct access may be a better term, as defined in a recent document: dental hygienists being "allowed to initiate treatment, based on their assessment of a patient's needs without the specific authorization of dentists, to treat the patient without the presence of a dentist, and to maintain a provider-patient relationship."²⁸ In 2001, ADHA developed a policy which stated that "dental hygienists who are graduates of accredited dental hygiene programs are competent to provide services without supervision."²⁹ This situation would increase the opportunities to care for the underserved population.

The major limitations of this study involve the lack of definition or clarification of terms used in the questionnaire. In the questionnaire no definitions of pathology were provided, and all statements related to pathology instruction were written specific to either general pathology or oral

pathology, with no mention of systemic pathology. Directors who are familiar with the term, systemic pathology, may have been confused as to how to address the statements related to student preparation based on the students' instruction in general pathology, because students may have been prepared for the task, not based on general pathology content, but on systemic pathology content. Another undefined term was "adequate preparation." Respondents may have interpreted this expression with various meanings of student proficiency. The intent was the extent of preparation for students to be deemed competent, defined by CODA as "the level of knowledge, skills, and values to begin the practice of dental hygiene."⁶ However, it is not clear whether respondents interpreted this in the same manner. "Training in pathology" was another ambiguous expression, not defined in the questionnaire. The authors intended that it would be interpreted as advanced education; even so, advanced education could have a broad range of educational possibilities, from completion of one continuing education course to being board certified in oral pathology. The authors neglected to formulate a question addressing these options, so the interpretation of the respondents is not known. Consequently, no data were collected to base a recommendation of the most appropriate qualification of an educator who would provide the majority of pathology instruction.

Clock hours may have been a weak choice to assess the amount of pathology instruction in the curriculum. Reporting clock hours may have required respondents to do the calculations, which could contribute to either an over or under estimate of classroom time. The authors assumed that program directors would have been familiar with reporting clock hours, as completion of the biannual survey of didactic clock hours requires listing of the clock hours, which provide instruction in the required content areas, such as general and oral pathology.³⁰ The wide variation in clock hours may have been due to the lack of clear pathology terms in the survey, causing the directors to interpret the questions differently.

Another limitation of this study is the low response rate (38%). Although the quick response time and ease of electronic surveys makes electronic surveys desirable to use, they tend to have lower response rates than mailed surveys.^{31,32} Internet surveys also have a higher proportion of incomplete questionnaires.³³ While in the current study, 174 (52%) questionnaires were started, only 130 (38%) were completed. A few program directors requested to forward the research questionnaire to the pathology instructor, so these surveys may

have been started by the program director, but not finished by the pathology instructor. As the population of electronic mail user increases, electronic surveys may become more popular and the user more likely to respond.³⁴

Conclusion

The majority of program directors, who responded to this survey, agreed that their current entry-level curricula do prepare graduates to deliver effective dental hygiene care to the medically compromised population. However, some study respondents strongly disagreed. These programs may benefit from a standardized curriculum, as well as evaluating the pathology learning experiences of their students and addressing the weaknesses. Applying the pathology curriculum guidelines, employing educators with advanced education in pathology, and introducing more and diverse multimedia resources into the curriculum

may strengthen these programs. As the population ages and the numbers of medically compromised patients increase, entry-level curricula will need to evolve to serve this patient population. Strengthening and standardizing pathology instruction among programs will ensure that future generations of dental hygienists will be adequately prepared to meet the increasingly complex medical and oral health needs of the public.

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References

1. Little JW, Falace DA, Miller CS, Rhodus NL. In: Dental management of the medically compromised patient. 7th ed. St. Louis: Mosby/Elsevier Publishing; 2008. p. 7.
2. U.S. Department of Health and Human Services. National call to action to promote oral health: a report of the Surgeon General. U.S. Department of Health and Human Services. 2000.
3. American Dental Hygienists' Association. National Dental Hygiene Research Agenda: revised March 2007. American Dental Hygienists' Association. [Internet]. 2007 [cited 2012 Sep 15]. Available from: http://www.adha.org/resources-docs/7834_NDHRA_Statements.pdf
4. Forrest JL, Spolarich AE. A Delphi study to update the American Dental Hygienists' Association National Dental Hygiene Research Agenda. *J Dent Hyg.* 2009;83(1):1-20.
5. ADEA compendium of curriculum guidelines (revised edition). Allied dental education programs: pathology for dental hygiene education. American Dental Education Association [Internet]. 2005 Feb [cited 2013 Nov 6]. Available from: <http://www.adea.org/sitecollectiondocuments/compendiumofcurriculumguidelinesforallieddentaleducationprograms.pdf>
6. American Dental Association Commission on Dental Accreditation. New and revised accreditation standards. [Internet]. 2011 [cited 2012 Sep 20]. Available from: http://www.ada.org/~media/CODA/Files/2016_dh.ashx
7. Systemic Pathology Definition. [Internet]. 2014 [cited 2014 Jan 10]. Available from: http://www.cram.com/search?query=systemic+pathology+lecture+1&image_filter=all&period=any&sm=1
8. Forrest J, Horowitz A, Shmuley Y. Dental hygienists' knowledge, opinions and practices related to oral and pharyngeal cancer risk assessment. *J Dent Hyg.* 2001;75(4):271-281
9. Community involvement: special care resources. University of the Pacific, Dugoni School of Dentistry [Internet]. 2012 [cited 2012 Sep 8]. Available from: [http://dental.pacific.edu/Community_Involvement/Pacific_Center_for_Special_Care_\(PCSC\)/Special_Care_Resources.html](http://dental.pacific.edu/Community_Involvement/Pacific_Center_for_Special_Care_(PCSC)/Special_Care_Resources.html)
10. RDHAP program spring 2014. West Los Angeles College [Internet]. 2012 [cited 2012 Sep 8]. Available from: <http://www.wlac.edu/allied-health/RDHAP%20Program%202014%20-%20Flyer.pdf>
11. Where life and learning meet. Metropolitan State University [Internet]. 2012 [cited 2012 Sep 20]. Available from: <http://www.metrostate.edu/msweb/explore/gradstudies/masters/msadt/>
12. Glasrud P, Emberston C, Day T, Diericks RW. Minnesota Dental Association: A history of Minnesota's dental therapist legislation: or ... what the heck happened up there? AAPD [Internet]. 2009 [cited 2012 Sep 20]. Available from: <http://www.aapd.org/assets/news/upload/2010/4131.pdf>
13. Position paper: access to care. American Dental Hygienists' Association. American Dental Hygienists' Association [Internet]. 2001 [cited 2013 Sep 20]. Available from: http://www.adha.org/resources-docs/7112_Access_to_Care_Position_Paper.pdf
14. Stolberg RL, Brickle CM, Darby MM. Development and status of the advanced dental hygiene practitioner. *J Dent Hyg.* 2011;85(2):83-91.
15. Norcini JJ, Holmboe ES, Hawkins RE. Evaluation challenges in the era of outcomes-based education. In: Holmboe ES, Hawkins RE, ed. Mosby/Elsevier's practical guide to the evaluation of clinical competence. 1st ed. Philadelphia: Mosby/Elsevier; 2008. p. 1-29.
16. Van Dyke TE, van Winkelhoff AJ. Infection and inflammatory mechanisms. *J Clin Periodontol.* 2013;40Suppl:S1-7.
17. Burzynski NJ, Rankin KV, Silverman S Jr, et al. Graduating dental students' perceptions of oral cancer education: results of an exit survey of seven dental schools. *J Cancer Educ.* 2002;17(2):83-84.
18. Rankin KV, Jones DL, McDaniel RK. Oral cancer education in dental schools: Survey of Texas dental students. *J Cancer Educ.* 1996;11(2):80-83.

19. Cannick GF, Horowitz AM, Drury TF, et al. Assessing oral cancer knowledge among dental students in South Carolina. *J Am Dent Assoc.* 2005;136(3):373-378.
20. Yellowitz JA, Horowitz AM, Drury TF, Goodman HS. Survey of U.S. dentists' knowledge and opinions about oral pharyngeal cancer. *J Am Dent Assoc.* 2000;131(5):653-661.
21. Cox JR. Enhancing student interactions with the instructor and content using pen-based technology, YouTube videos, and virtual conferencing. *Biochem Mol Biol Educ.* 2011;39(1):4-9.
22. Kumar RK, Velan GM, Korell SO, et al. Virtual microscopy for learning and assessment in pathology. *J Pathol.* 2004;204(5):613-618.
23. Subramanian A, Timberlake M, Mittakanti H, et al. Novel educational approach for medical students: improved retention rates using interactive medical software compared with traditional lecture-based format. *J Surg Educ.* 2012;69(4):449-452.
24. Marsh KR, Giffin BF, Lowrie DJ Jr. Medical student retention of embryonic development: Impact of the dimensions added by multimedia tutorials. *Anat Sciences Educ.* 2008;1(6):252-257.
25. Stegeman CA, Zydney J. Effectiveness of multimedia instruction in health professions education compared to traditional instruction. *J Dent Hyg.* 2010;84(3):130-136.
26. Snyder J. CODA and dental hygiene's changing world. *Access.* 2012;26(10):18-19.
27. Mertz E, Grossman P. Alternative practice dental hygiene in California: Past, present, and future. *J Calif Dent Assoc.* 2011;39(1):37-46.
28. NGA paper: the role of dental hygienists in providing access to oral health care. National Governors Association [Internet]. 2014 [cited 2014 Jan 8]. Available from: <http://www.nga.org/cms/home/nga-center-for-best-practices/center-publications/page-health-publications/col2-content/main-content-list/the-role-of-dental-hygienists-in.html>
29. Policy manual. American Dental Hygienists' Association [Internet]. 2012 Jul 30 [cited 2013 June 9]. Available from: http://adha.org/resources-docs/7614_Policy_Manual.pdf
30. American Dental Association Survey Center. 2009-2010 survey of allied dental education. American Dental Association [Internet]. 2011 [cited 2013 November 6]. Available from: http://www.agd.org/files/webuser/website/membership/vol.%201_academic%20programs_enrollment_graduates.pdf
31. Akl EA, Maroun N, Klocke RA, et al. Electronic mail was not better than postal mail for surveying residents and faculty. *J Clin Epidem.* 2005;58(4):425-429.
32. Leece P, Bhandari M, Sprague S, et al. Internet versus mailed questionnaires: A randomized comparison. *J Med Internet Res.* 2004;6(4):39-54.
33. McCabe SE, Boyd CJ, Couper MP, et al. Mode effects for collecting alcohol and other drug use data: Web and U.S. mail. *J Stud Alcohol.* 2002;63(6):755-761.
34. Lusk C, Delclos GL, Burau K, et al. Mail versus internet surveys: determinants of method of response preferences among health professionals. *Eval Health Prof.* 2007;30(2):186-201.

The Relationship between Methamphetamine Use and Dental Caries and Missing Teeth

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Introduction

Both the illicit production and the use of methamphetamine, a powerful stimulant that affects the central nervous system, have a tremendous impact on people's lives and on national and state resources.¹ Between 1996 and 2012, the percentage of adults admitted to treatment facilities for methamphetamine increased from 2.6 to 8.5% for the nation and from 9.7 to 21.9% for Iowa.² In addition to burdening the health care system, methamphetamine production and use have negatively impacted the criminal justice system. In 2012, 50.9% of people imprisoned on drug charges in Iowa had committed a crime related to the drug methamphetamine.³

Methamphetamine use has been purported to cause destructive dental caries. Some authors have suggested that it may be the chemical or physical qualities of methamphetamine or its components, such as their acidity or toxicity, directly attacking tooth structure.^{4,5} Other studies suggest that methamphetamine causes dry mouth which reduces protective aspects of saliva.⁶⁻⁸ Others do not attribute it to methamphetamine but to users' poor oral hygiene, high consumption of refined carbohydrates and lack of routine dental care.^{4,8,9} The relationship between methamphetamine use and poor oral health was first suggested for prescription use of methamphetamine and then illicit use.^{10,11} The relationship with illicit use has been reported in a number of articles,^{4,5,8,9,11-25} and has been investigated in research studies which measured oral health by self-report²⁶⁻²⁹ and by clinical examinations or screen-

ings.^{7,30-33} Of the studies using clinical data, mixed results were found from bivariate analyses. Two studies concluded that methamphetamine use had a negative impact on oral health,^{7,32} and 2 studies reported that there was no impact.^{30,31} Multivari-

Abstract

Purpose: This study examined the relationship between methamphetamine use and oral health status.

Methods: Using a cross-sectional design, data were collected in 1998 from 174 newly admitted prisoners in Iowa. Oral examinations identified dental caries and missing teeth, and personal interviews identified methamphetamine use and covariates. Descriptive statistics were used to summarize the data, and bivariate and multivariate linear regression analyses, including testing for interaction effects, were used to examine the effects of methamphetamine use on oral health status.

Results: Multivariate regression analyses for carious teeth and surfaces showed significant interaction effects: methamphetamine*race/ethnicity (carious teeth: $p=0.039$; surfaces: $p=0.023$) and methamphetamine*tooth brushing when on drugs (carious teeth: $p=0.044$; surfaces: $p=0.035$). Methamphetamine use had a significant effect on dental caries among Non-Whites and among those who brushed their teeth less than once a day when on drugs. Soda consumption (carious teeth: $p=0.026$; surfaces: $p=0.030$) and reason for last dental visit (carious teeth: $p=0.025$; surfaces: $p=0.011$) were also associated with caries. For missing teeth there was a significant methamphetamine*race/ethnicity interaction ($p=0.028$) among Whites who used methamphetamine compared to Whites who did not use methamphetamine. Age ($p=0.0001$) and reason for last dental visit ($p=0.0001$) were also associated with missing teeth.

Conclusion: The effect of methamphetamine use on missing teeth was moderated by race/ethnicity,; while its effect on dental caries was moderated by race/ethnicity and tooth brushing when on drugs.

Keywords: methamphetamine use, polydrug use, caries, missing teeth, oral epidemiology

This study supports the NDHRA priority area, **Health Promotion/Disease Prevention:** Investigate how environmental factors (culture, socioeconomic status-SES, education) influence oral health behaviors.

ate analysis also resulted in mixed results. Controlling for demographic variables, professional care, oral hygiene, sugar consumption and tobacco use, Cretzmeyer et al found that oral health (number of teeth present and total filled and carious surfaces) was not statistically different for methamphetamine abusers and those who abused other drugs.³¹ Conversely, Shetty et al, controlling for demographic and professional care variables, found that methamphetamine abusers had more missing teeth and poorer self-reported oral health than adult NHANES III respondents; however, they did not find a difference for dental caries.³³ Based on a systematic review of methamphetamine use and health for adolescents, Marshall and Werb concluded that there is a research gap in that there is insufficient evidence of an association between methamphetamine use and dental outcomes and that future research should assess potential covariates and adjust for them using stratified or multivariate analyses.³⁴

This study examined the relationship between methamphetamine use and oral health using data collected in 1998 from a population of recently admitted prisoners. This study is important because previous research has not resolved this question. Studies using clinical measures of oral health status are few in number and none of these studies adequately controlled for covariates. Additionally, the findings from these studies have been inconsistent. A better understanding of the relationship of methamphetamine use on oral health status should assist dental professions in providing treatment to methamphetamine users, especially preventive services like those provided by dental hygienists, and could have implications for policy decisions related to dental care for methamphetamine users in prisons, drug treatment centers and dental health clinics.

Methods and Materials

This cross-sectional study was conducted within the confines of the staff dental hygienists' work day. Oral health evaluations and personal interviews were used to collect data from a sample of inmates newly admitted to the Iowa Medical Classification Center (IMCC) between June and December 1998.

All inmates entering Iowa's prison system are evaluated at the IMCC for mental and physical health conditions. Oral health evaluations are conducted on the day after admission and new inmates are examined by the staff dentist or dental hygienist. Mouth mirrors, explorers and panoramic radiographs are standard equipment used

at the IMCC to evaluate each tooth surface for each inmate and the oral health information is recorded on the IMCC anatomical odontogram, a chart depicting the crown and root for each of the 32 teeth possibly present in an adult mouth. Because the evaluations are conducted to determine treatment needs, adequate fillings are not differentiated from sound surfaces. When the data were collected, the dental hygienist had 16 years of clinical experience, 3 years at IMCC, 7 years at a maximum security prison and 6 years in private practice. The purpose of the study was discussed with the dental and medical directors and warden during the planning phase and a design which restricted data collection to the dental hygienist's patients was accepted. The medical director and warden approved the study protocol and consent form. The University of Iowa institutional review board (IRB) determined that, because this study was limited to analysis of de-identified data, it did not meet the regulatory definition of research involving human subjects and therefore was not subject to further IRB review.

As stated above, study participants were drawn from the inmates evaluated by the staff dental hygienist. On days when there were too many inmates for the dental hygienist to both provide an oral health evaluation and collect study data, a set format of offering study participation to every second, third or fourth inmate, depending on the number of inmates to be examined, was used. Within this time constraint, inmates were invited to be a part of the study and there were no exclusions based on gender, race, age or any other covariate. Inmates who elected to participate were read the consent form, which they signed prior to the oral health evaluation.

Photocopies of the odontograms were made and identifying information was removed. Each photocopy and corresponding questionnaire was given a unique identifier. Oral health was measured by 3 variables: total number of carious teeth, total number of carious surfaces and total number of missing teeth. For the study, incipient lesions, those not into the dentin, were excluded, which is consistent with oral health epidemiological and survey research.

Data regarding demographic, oral hygiene, professional dental care, sugar consumption and drug use were obtained from personal interviews administered by the dental hygienist after the oral evaluation. Demographic variables included sex, age, race/ethnicity, education, marital status and employment. Oral hygiene was measured by usual tooth brushing frequency, using a 6-point scale

from 3 or more times/day to less than weekly, and tooth brushing frequency when on drugs. The latter was obtained with the open-ended question "When you were using drugs, how frequently did you brush your teeth?" Of 92 subjects' responses (measured on the 6-point scale previously described), 32 stated they brushed the same as usual, 23 stated they never brushed when on drugs and were coded at the lowest frequency, 4 stated they brushed more when on drugs and were raised 1 usual frequency level, 20 stated they did not use drugs or only cigarettes and were coded at their usual frequency, and 3 subjects' answers could not be coded. For regression analysis, the 3 were included using their respective usual frequencies. Professional dental care included the number of years since the last dental visit and the reason for the last dental visit. Consumption of 8 types of sweetened beverage and food was measured with the same 6-point scale as tooth brushing. Sugar consumption was analyzed using 2 variables: soda (the frequency of soda consumption) and non-soda sugars (a summed variable of the other 7 sugar items). For multivariate analysis, both sugar variables were rendered closer to scale by converting them to the common denominator of times per week. Participants were asked if they had ever used tobacco, alcohol, marijuana, methamphetamine, other stimulants, cocaine and heroin and were given the option to name up to 2 additional drugs. Respondents were divided into users and non-users for each of the drugs for data analysis.

Data were entered in the computer by student research assistants and one of the authors. All data were verified and then analyzed using IBM SPSS Statistics 19 and SAS.

Distributions and descriptive statistics were calculated. Bivariate analysis was conducted to test for differences between users and non-users of methamphetamine. Continuous, normally-distributed variables were compared using two-sample t tests, while Mann-Whitney U Tests were used for non-normally distributed and ordinal variables. Pearson's chi-square or the Fisher's Exact Test was used for comparing categorical variables. Bivariate analysis was also conducted to examine the association of covariates with the 3 dependent variables using Spearman's Rho, Mann-Whitney U Tests and Kruskal-Wallis Tests.

Since the primary objective was to describe the effect of methamphetamine use on oral health controlling for the influence of covariates, multivariate linear regression analysis was used. Separate regression models were analyzed for each of

the 3 oral health dependent variables. As none of the oral health variables was normally distributed, they were transformed for regression analysis: caries with the square root transformation and missing teeth with the natural log transformation.^{35,36}

The covariates included in the regression models were demographics (sex, age, race/ethnicity and marital status), sugar consumption (soda and non-soda sugars), personal oral hygiene (tooth brushing frequency when on drugs), professional dental care (number of years since last dental visit and reason for last dental visit) and drug use (tobacco, alcohol, methamphetamine, marijuana and cocaine). Heroin use was not included due to the small number of heroin users (n=6). None of the sample used other stimulants.

In addition to fitting a main-effects-only-regression model, interaction effects involving methamphetamine and other covariates were also examined. This was done by fitting separate regression models with a single interaction effect added to the main effects model. Interaction effects with a p-value ≤ 0.10 were considered for possible inclusion in the final model. The presence of a significant interaction effect of any of these variables with methamphetamine indicates that the effect of methamphetamine on caries or missing teeth is moderated by this variable. Among the interaction effects that were tested, there were 3 variables that met the inclusion criteria: race/ethnicity, age and frequency of tooth brushing when on drugs. Regression models were then fitted that included various combinations of these interaction variables. The extent to which each model provided the best fit was assessed by the Akaike Information Criterion.³⁷

From the final model that included interaction effects, the effect of methamphetamine was then examined using the test of mean contrast to test for differences in dental caries or missing teeth between methamphetamine users and non-users at each level of the moderating variable. Since multiple tests were performed to test for the effect of methamphetamine (i.e. 2 tests by race/ethnicity), the p-values for these tests were adjusted using Bonferroni's method.³⁸

Results

There were 174 individuals in the study, with only one individual declining to participate (99.4%). The average age was 30 years (SD=8.3,

Table I: Distribution of Subjects by Covariates and by Methamphetamine Use

Variable	Total (n=174) n (percent)	Meth User (n=95) n (percent)	Meth Non-user (n=79) n (percent)	p-value
Age (in years)				0.596 ^t
17 to 20	25 (14.4%)	9 (9.5%)	16 (20.2%)	
21 to 30	75 (43.1%)	43 (45.3%)	32 (40.5%)	
31 to 40	55 (31.6%)	40 (42.1%)	15 (19.0%)	
41 to 55	19 (10.9%)	3 (3.2%)	16 (20.2%)	
Sex				0.006 ^P
Male	149 (85.6%)	75 (78.9%)	74 (93.7%)	
Female	25 (14.4%)	20 (21.1%)	5 (6.3%)	
Race/Ethnicity				<0.001 ^P
White	142 (81.6%)	89 (93.7%)	53 (67.1%)	
Non-White	32 (18.4%)	6 (6.3%)	26 (32.9%)	
Marital status				0.060 ^P
Never married	88 (50.6%)	42 (44.2%)	46 (58.2%)	
Married	39 (22.4%)	23 (24.2%)	16 (20.3%)	
Divorced/separated	46 (26.4%)	29 (30.5%)	17 (21.5%)	
Widowed	1 (0.6%)	1 (1.0%)	0 (0.0%)	
Education (highest grade completed)				0.244 ^M
5 to 11	70 (40.2%)	41 (43.2%)	29 (36.7%)	
12	41 (23.6%)	21 (22.1%)	20 (25.3%)	
GED	45 (25.9%)	28 (29.5%)	17 (21.5%)	
Some college	18 (10.3%)	5 (5.3%)	13 (16.5%)	
Employment				0.355 ^P
Full time	136 (78.2%)	72 (75.8%)	64 (81.0%)	
Part time	11 (6.3%)	6 (6.3%)	5 (6.3%)	
Unemployed/laid off	21 (12.1%)	15 (15.8%)	6 (7.6%)	
On disability	4 (2.3%)	1 (1.0%)	3 (3.8%)	
Homemaker	2 (1.1%)	1 (1.0%)	1 (1.3%)	
Usual tooth brushing frequency				0.739 ^{M*}
3 or more per day	23 (13.2%)	13 (13.7%)	10 (12.7%)	
2x per day	62 (35.6%)	32 (33.7%)	30 (38.0%)	
1x per day	69 (39.7%)	43 (45.3%)	26 (32.9%)	
3 to 6x per week	11 (6.3%)	4 (4.2%)	7 (8.9%)	
1 to 2x per week	5 (2.9%)	2 (2.1%)	3 (3.8%)	
<weekly	4 (2.3%)	1 (1.1%)	3 (3.8%)	
On drugs tooth brushing frequency [#]				0.907 ^{M*}
3 or more per day	16 (9.4%)	8 (8.7%)	8 (10.1%)	
2x per day	47 (27.5%)	23 (25.0%)	24 (30.4%)	
1x per day	63 (36.8%)	36 (39.1%)	27 (34.2%)	
3 to 6x per week	16 (9.4%)	9 (9.8%)	7 (8.9%)	
1 to 2x per week	5 (2.9%)	2 (2.2%)	3 (3.8%)	
<weekly	24 (14.0%)	14 (15.2%)	10 (12.7%)	

t=t-Test; P=Pearson Chi Square; M=Mann-Whitney U Test; M*=Mann-Whitney U Test (based on the 6 ordinal responses on frequency of use); F=Fisher's Exact Test; #User=92; ##Non-user=78; ###User=94

range 17 to 53), 85.6% were male, 81.6% were White, 50.6% had never been married, 49.5% had either graduated high school or obtained a GED, and 78.2% had been employed full-time prior to incarceration (Table I).

The main reasons for last dental visit were a toothache (55.2%), checkup (28.2%) and other dental work (15.5%). More than half (n=101,

57.9%) had not been to the dentist in the past year and the average number of years since last dental visit was 4 (SD=4.3).

Most subjects usually brushed their teeth once (39.7%) or twice a day (35.6%); however, when subjects were using drugs, 36.8% brushed once a day and only 27.5% brushed twice a day. While 2.3% of subjects usually brushed less than

Table I: Distribution of Subjects by Covariates and by Methamphetamine Use (continued)

Variable	Total (n=174) n (percent)	Meth User (n=95) n (percent)	Meth Non-user (n=79) n (percent)	p-value
Years since last dental visit				0.042 ^M
1	73 (42.0%)	47 (49.5%)	26 (32.9%)	
2	20 (11.5%)	10 (10.5%)	10 (12.7%)	
3 to 4	22 (12.6%)	9 (9.5%)	13 (16.4%)	
5 to 9	35 (20.1%)	19 (20.0%)	16 (20.2%)	
10 to 25	22 (12.6%)	9 (9.5%)	13 (16.4%)	
Never been	2 (1.1%)	1 (1.0%)	1 (1.3%)	
Reason for last dental visit				0.032 ^P
Toothache	96 (55.2%)	62 (65.3%)	34 (43.0%)	
Other work	27 (15.5%)	8 (8.4%)	19 (24.1%)	
Check up	49 (28.2%)	24 (25.3%)	25 (31.6%)	
Never been	2 (1.1%)	1 (1.1%)	1 (1.3%)	
Number of drugs				<0.001 ^F
None	12 (6.9%)	0 (0.0%)	12 (15.2%)	
Only one	18 (10.3%)	1 (1.1%)	17 (21.5%)	
Multiple	144 (82.8%)	94 (98.9%)	50 (63.3%)	
Ever used drugs				
Tobacco				<0.001 ^F
Yes	151 (86.8%)	92 (96.8%)	59 (74.7%)	
No	23 (13.2%)	3 (3.2%)	20 (25.3%)	
Alcohol				0.508 ^P
Yes	101 (58.0%)	53 (55.8%)	48 (60.8%)	
No	73 (42.0%)	42 (44.2%)	31 (39.2%)	
Marijuana				<0.001 ^P
Yes	91 (52.3%)	67 (70.5%)	24 (30.4%)	
No	83 (47.7%)	28 (29.5%)	55 (69.6%)	
Cocaine				<0.001 ^P
Yes	41 (23.6%)	33 (34.7%)	8 (10.1%)	
No	133 (76.4%)	62 (65.3%)	71 (89.9%)	
Heroin				0.032 ^F
Yes	6 (3.4%)	6 (6.3%)	0 (0.0%)	
No	168 (96.6%)	89 (93.7%)	79 (100.0%)	
Other				0.060 ^P
Yes	14 (8.0%)	11 (11.6%)	3 (3.8%)	
No	160 (92.0%)	84 (88.4%)	76 (96.2%)	

t=t-Test; P=Pearson Chi Square; M=Mann-Whitney U Test; M*=Mann-Whitney U Test (based on the 6 ordinal responses on frequency of use); F=Fisher's Exact Test; #User=92; ##Non-user=78; ###User=94

weekly, 14.0% brushed less than weekly when on drugs.

Almost half or more of the subjects reported that they ingested soda (83.3%), chips and/or snack crackers (59.0%), cake and/or cookies (54.3%), or candy (47.1%) at least once a day. Soda was consumed 3 or more times a day by 64.9% of the subjects for a mean consumption of 15.9 times per week. Non-soda sugars were consumed, on average, 34.7 times per week.

While the majority of subjects (82.8%) used multiple drugs, 12 did not use any drugs and 18 used only 1 drug. Four drugs were used by more than half of the subjects: tobacco (86.8%), alcohol (58.0%), methamphetamine (54.6%) and marijuana (52.3%). Cocaine was used by 23.6% of the subjects and heroin by 3.4%. Fourteen subjects reported using other types of drugs.

Bivariate analysis determined significant associations between methamphetamine use and being White, being female, having visited the

Table I: Distribution of Subjects by Covariates and by Methamphetamine Use (continued)

Variable	Total (n=174) n (percent)	Meth User (n=95) n (percent)	Meth Non-user (n=79) n (percent)	
Sugar consumption				
Soda				0.007 ^{M*}
1 to 3x per day	145 (83.3%)	84 (88.4%)	61 (77.2%)	
1 to 6x per week	13 (7.5%)	4 (4.2%)	9 (11.4%)	
<weekly	16 (9.2%)	7 (7.4%)	9 (11.4%)	
Chips/crackers ^{##}				0.339 ^{M*}
1 to 3x per day	102 (59.0%)	59 (62.1%)	43 (55.1%)	
1 to 6x per week	34 (19.7%)	18 (18.9%)	16 (20.5%)	
<weekly	37 (21.4%)	18 (18.9%)	19 (24.4%)	
Cakes/cookies ^{###}				0.149 ^{M*}
1 to 3x per day	94 (54.3%)	57 (60.6%)	37 (46.8%)	
1 to 6x per week	29 (16.8%)	16 (17.0%)	13 (16.5%)	
<weekly	50 (28.9%)	21 (22.3%)	29 (36.7%)	
Candy				0.188 ^{M*}
1 to 3x per day	82 (47.1%)	49 (51.6%)	33 (41.8%)	
1 to 6x per week	41 (23.6%)	23 (24.2%)	18 (22.8%)	
<weekly	51 (29.3%)	23 (24.2%)	28 (35.4%)	
Kool-Aid/lemonade				0.759 ^{M*}
1 to 3x per day	62 (35.6%)	34 (35.8%)	28 (35.4%)	
1 to 6x per week	19 (10.9%)	9 (9.5%)	10 (12.7%)	
<weekly	93 (53.4%)	52 (54.7%)	41 (51.9%)	
Sweetened cereal ^{##}				0.312 ^{M*}
1 to 3x per day	58 (33.5%)	35 (36.8%)	23 (29.5%)	
1 to 6x per week	23 (13.3%)	12 (12.6%)	11 (14.1%)	
<weekly	92 (53.2%)	48 (50.5%)	44 (56.4%)	
Sweet rolls/cereal bars				0.391 ^{M*}
1 to 3x per day	55 (31.6%)	32 (33.7%)	23 (29.1%)	
1 to 6x per week	17 (9.8%)	10 (10.5%)	7 (8.9%)	
<weekly	102 (58.6%)	53 (55.8%)	49 (62.0%)	
Sweetened coffee/tea				0.099 ^{M*}
1 to 3x per day	45 (25.9%)	28 (29.5%)	17 (21.5%)	
1 to 6x per week	8 (4.6%)	5 (5.3%)	3 (3.8%)	
<weekly	121 (69.5%)	62 (65.3%)	59 (74.7%)	

t=t-Test; P=Pearson Chi Square; M=Mann-Whitney U Test; M*=Mann-Whitney U Test (based on the 6 ordinal responses on frequency of use); F=Fisher's Exact Test; #User=92; ##Non-user=78; ###User=94

dentist in the previous year, having visited the dentist for a toothache, having consumed soda at the highest frequency, using multiple drugs, using tobacco, using marijuana, using cocaine, and using heroin (Table I).

Eighteen participants had no teeth with untreated dental caries and 32 had no missing teeth. Users had significantly higher numbers of carious teeth (p=0.020), carious surfaces (p=0.018) and missing teeth (p=0.009) than those who had never used methamphetamine (Table II).

The significant bivariate associations between each covariate and the dependent variables of

carious teeth and surfaces are as follows. Dental caries were significantly greater among those using methamphetamine (carious teeth: p=0.020; surfaces: p=0.018), being White (carious teeth: p=0.016; surfaces: p=0.014), consuming soda more frequently (carious teeth: p=0.000; surfaces: p=0.002), brushing once a day or less when on drugs (carious teeth: p=0.031; surfaces: p=0.050), and visiting the dentist for a toothache or other work (carious teeth: p=0.030; surfaces: p=0.005). The number of missing teeth was significantly greater among those using methamphetamine (p=0.009), being older (p=0.000), being male (p=0.021), being married (p=0.000), not visiting the dentist in the past

Table II: Summary Statistics for Oral Health Variables and Statistical Significance by Methamphetamine Use

Variable	Mean	SD	Median	Q1	Q3	p-valueM
Decayed teeth						0.02
Total	6.9	5.8	6	3	10	
User	7.8	6.2	7	3	10	
Non-user	5.8	5.1	4	2	8	
Decayed surfaces						0.018
Total	17.5	17.4	14	5	23	
User	20.4	19.2	15	6	28	
Non-user	13.9	14.1	11	4	20	
Missing teeth						0.009
Total	4.2	4.3	3	1	6	
User	4.7	3.9	4	2	7	
Non-user	3.7	4.7	3	1	4	

M=Mann-Whitney U Test; SD=Standard Deviation; Q1=25th Percentile; Q3=75th Percentile

year (p=0.004), and visiting the dentist for a toothache or other work (p=0.000).

Regression analyses to control for covariates in assessing the effect of methamphetamine use on dental caries showed a significant interaction between methamphetamine use and race/ethnicity (cariou teeth: p=0.039; surfaces: p=0.023) and a significant interaction between methamphetamine use and tooth brushing frequency when on drugs (cariou teeth: p=0.044; surfaces: p=0.035) (Table III). Among Non-Whites there were significantly more cariou teeth and surfaces in methamphetamine users (n=6) compared to non-users (n=26) (Bonferroni adjusted p=0.014 and p=0.011, respectively). However, no significant effect of methamphetamine was seen among Whites (cariou teeth Bonferroni adjusted p=0.367; cariou surfaces Bonferroni adjusted p=0.287) (Table IV). Likewise, among those who brushed their teeth less than once a day when on drugs, there were significantly more cariou teeth and surfaces in methamphetamine users (n=25) compared to non-users (n=20) (Bonferroni adjusted p=0.007 and p=0.003, respectively). There was no significant effect of methamphetamine on cariou teeth and surfaces (Bonferroni adjusted p=0.216 and p=0.221, respectively) among those who brushed their teeth at least once a day when on drugs (Table IV). Other significant covariates for dental caries were reason for last dental visit (cariou teeth: p=0.025; surfaces: p=0.011) and soda (cariou teeth: p=0.026; surfaces: p=0.030). Those who visited the dentist for a toothache or other work and those who more frequently consumed soda had more cariou teeth and surfaces (Table III).

For missing teeth, regression analyses to assess the effect of methamphetamine use showed a significant methamphetamine and race/ethnicity interaction (p=0.028) (Table III). This interaction indicated that the effect of methamphetamine on missing teeth differed within race/ethnicity categories, with significantly more missing teeth in Whites who used methamphetamine (n=89) than in Whites who did not (n=53) (Bonferroni adjusted p=0.038). There was no significant association between methamphetamine use on missing teeth among Non-Whites (Bonferroni adjusted p=0.431) (Table IV). Other significant covariates were age (p=0.0001) and reason for last dental visit (p=0.0001). Being older and visiting the dentist for a toothache or other work resulted in more missing teeth (Table III).

Discussion

Previous studies reported a lower percentage of methamphetamine users who brushed their teeth at least daily when on drugs (35.3 to 41%)³⁰⁻³³ than found in this study (72.8%). Only one study reported a significant bivariate relationship between methamphetamine use and tooth brushing when on drugs.³² While this study did not find significant bivariate relationships between methamphetamine use and usual tooth brushing and methamphetamine use and tooth brushing when on drugs, it did find a significant bivariate relationship between tooth brushing when on drugs and dental caries. Additionally, multivariate analysis of this data indicated that methamphetamine use results in statistically more dental caries for those who brush less than once a day when on drugs.

Table III: Regression Coefficient Estimates and Statistical Significance of the Fitted Models with Interaction Effects for Each Oral Health Variable

Variable	Decayed Teeth			Decayed Surfaces			Missing Teeth		
	b	SE	p-value	b	SE	p-value	b	SE	p-value
Intercept	0.698	0.645	0.281	0.405	1.096	0.712	-0.237	0.342	0.489
Methamphetamine use	-0.066	0.268	0.806	-0.145	0.456	0.751	0.314	0.132	0.019
Cocaine use	-0.038	0.230	0.869	-0.043	0.392	0.912	-0.060	0.123	0.625
Marijuana use	0.076	0.214	0.722	0.234	0.363	0.520	0.155	0.113	0.174
Tobacco use	-0.051	0.288	0.860	-0.362	0.489	0.461	0.153	0.153	0.322
Alcohol use	-0.145	0.197	0.462	-0.237	0.334	0.479	-0.104	0.104	0.316
Sex (male)	0.427	0.274	0.122	0.521	0.466	0.265	-0.083	0.146	0.571
Age	0.010	0.015	0.494	0.041	0.025	0.104	0.032	0.008	<.000
Race/ethnicity (Non-White)	-0.624	0.290	0.033	-1.093	0.493	0.028	0.385	0.154	0.013
Never married (other)	0.074	0.261	0.777	0.114	0.444	0.798	-0.052	0.138	0.707
Married (other)	-0.063	0.265	0.812	0.033	0.451	0.941	0.078	0.141	0.584
Last visit to dentist (>1 year)	0.279	0.202	0.170	0.450	0.343	0.192	-0.185	0.108	0.088
Reason for last visit to dentist (toothache/other)	0.499	0.220	0.025	0.965	0.374	0.011	0.500	0.117	<.000
On drugs tooth brushing frequency (<1/day)	-0.200	0.322	0.536	-0.463	0.548	0.400	0.160	0.111	0.151
Soda	0.030	0.014	0.026	0.051	0.023	0.030	0.008	0.007	0.254
Non-soda sugars	0.002	0.004	0.598	0.005	0.007	0.475	0.000	0.002	0.858
Methamphetamine*race/ethnicity	1.204	0.579	0.039	1.645	0.718	0.023	-0.684	0.308	0.028
Methamphetamine*On drugs tooth brushing frequency	0.856	0.422	0.044	2.097	0.985	0.035	-	-	-
R squared			19%			21%			41%

SE=Standard Error

Previous methamphetamine studies did not include reason for dental visit, which this analysis found was related to both dental caries and missing teeth. In this study, subjects who saw the dentist for toothaches or other treatment had poorer oral health than those who saw the dentist for a check-up. In addition to the advanced stage of disease, the large number of missing teeth found in these prisoners may reflect the culture of dental care.³⁹

In 3 previous studies, consumption of soda varied from 35.3%³⁰ to 94%³² among methamphetamine users. This study found that 92.6% of methamphetamine users consumed soda. Morio et al found a significant difference in percent consuming soda between methamphetamine users and non-users, as was found in this study.³² However, Cretzmeyer et al³¹ and Brown et al³⁰ did not. This analysis found that the frequency of soda consumption correlated with dental caries, as

did Ravenel et al,⁷ but Cretzmeyer et al³¹ did not. When covariates were controlled, soda consumption remained significantly related to dental caries. None of the other sugar variables studied individually or as a combined frequency correlated with methamphetamine use or with dental caries. Sugar variables, including soda consumption, were not related to missing teeth.

In addition to this study, Cretzmeyer et al were the only ones to investigate the relationship between age and oral health.³¹ Although they found that methamphetamine users were significantly younger than their other-substance-abuse comparison group, logistic regression indicated that age was not related to oral health. In this study age was not related to methamphetamine use nor to dental caries; however, age was related bivariate and multivariate to missing teeth, with older inmates having more missing teeth.

Table IV: Effect of Methamphetamine on Oral Health Variables Based on Estimates from the Regression Models

Oral Health Measures	Interaction	User			Non-user			p-value ^B
		n	mean	SE	n	mean	SE	
Decayed teeth	Methamphetamine*race/ethnicity							
	Non-Whites	6	9.7	3.0	26	3.1	0.9	0.014
	Whites	89	6.8	1.0	53	5.2	1.2	0.367
	Methamphetamine*On drugs toothbrushing frequency							
	Less than once a day	25	10.1	2.1	20	3.7	1.2	0.007
	Once a day or more	70	6.6	1.4	59	4.4	0.9	0.216
Decayed surfaces	Methamphetamine*race/ethnicity							
	Non-Whites	6	26.8	8.4	26	8.0	2.3	0.011
	Whites	89	18.7	2.8	53	13.9	2.9	0.287
	Methamphetamine*On drugs toothbrushing frequency							
	Less than once a day	25	28.2	5.9	20	9.4	2.9	0.003
	Once a day or more	70	18.0	3.8	59	12.0	2.4	0.221
Missing teeth	Methamphetamine*race/ethnicity							
	Non-Whites	6	2.1	0.8	26	3.5	0.7	0.431
	Whites	89	3.2	0.5	53	2.1	0.4	0.038

B=Bonferroni Adjusted Method
Means and Standard Errors (SE) Computed by Back Transformation

Although methamphetamine users commonly use other illicit drugs,⁴⁰ previous researchers^{7,30-33} did not investigate them. In this study, while use of tobacco, marijuana, cocaine and heroin were significantly correlated with methamphetamine use, none of these drugs correlated with dental caries and missing teeth. Additionally, multivariate analyses controlled for these 4 drugs and none was found to be related to the oral health variables. However, polydrug use was high and this sample of 174 subjects was not adequate to consider all the interaction effects of the drugs with methamphetamine.

The findings that methamphetamine's effects on dental caries are moderated by tooth brushing when on drugs, and that the reason for dental visit influences both caries and missing teeth, suggest intervention points. One intervention would focus on preventive behaviors. For persons with few dental caries, secondary preventive measures would comprise appropriate traditional home care and routine dental visits. However, many of the prisoners in this study are at the tertiary level and may require prescription strength fluoride tooth-

paste, frequent professional cleanings and elimination of soda. Since methamphetamine use may alter saliva so that it is more acidic and has less buffering capacity, saliva testing and appropriate neutralizing and re-mineralizing agents should be considered.⁷ Drugs used to treat drug abuse should not have high sugar content.

Researchers have found that habituated oral health behaviors can withstand changes in a person's social environment, and this underscores the importance of primary prevention.⁴¹ Had the methamphetamine users in this study had well-established oral care habits they would have maintained their usual higher tooth brushing frequency and regular dental visits when on drugs. This would have reduced the number and size of carious lesions for the prisoners who used methamphetamine. Given what is known about developing dental health habits, primary prevention should start at birth.⁴²⁻⁴⁵

Changing adults' health behavior is not easy, nor is altering dental procedures in institutions. Research on dental hygienists' role in providing

preventive services to drug users has not been reported. However, given administrative support for establishing policies and funding, these interventions are within the scope of dental hygiene practice and thus could be provided cost-effectively by dental hygienists. It is likely that dental hygienists, especially those employed in rehabilitation or correctional facilities, could advocate for restrictions on access to sodas and other sugar intake similar to those for diabetic prisoners, for shorter intervals for prophylaxes and closer supervision of personal oral hygiene.

Another intervention to consider would be dental screenings for high school seniors, especially in states where methamphetamine use is prevalent. In the newly admitted prisoners in this study, by age 18, 63% of this high risk group had tried methamphetamine. Thus, such a dental screening program may not only lead to early detection of dental caries and the prevention of destructive caries but may also lead to early identification of drug use.

While these interventions are primarily directed at dental caries, they also would address missing teeth. Osborn found that approximately 86% of prisoners ages 25 to 40 needed teeth extracted due to dental caries; for those younger than 25 and those older than 40, 65% needed extraction.⁴⁶

A limitation of this study which may have influenced the results was that the number of missing teeth attributed to dental disease may have been over-estimated because the reason for teeth being absent was not ascertained. In addition to dental disease, teeth could have been missing due to trauma and orthodontic care. Salive suggested that the higher mean number of missing teeth in the prisoners he studied, as compared to a national sample, may have been due to trauma.⁴⁷

Additionally, there were 3 variables which were not captured completely: the upper limit of soda consumption, the lower limit of tooth brushing when on drugs and a complete history of dental caries (because filled teeth were not charted as part of the oral examination at the IMCC). However, it is unlikely that these limitations on completeness altered the findings of this study.

Since the data were collected 16 years ago, this raises the question: Are the data still pertinent today? The authors believe they are for a number of reasons. Methamphetamine use still creates a meaningful and growing burden on health care facilities and penal institutions in Iowa.^{2,3} Methamphetamine used in 2014 in Iowa is purer than

that which was used in 1998.³ Whether more pure methamphetamine would result in higher levels of decay is unknown. If it did, methamphetamine users would be further differentiated from non-users. The research methodology used in this study is consistent with current approaches and the Substance Abuse and Mental Health Services Administration's measurement of methamphetamine use.⁴⁰ The dental evaluations are conducted in the same manner at the IMCC, and dental caries and missing teeth are still common measures of oral health status. Dental caries preventive and treatment procedures have changed little since 1998.

The prison population was selected because the authors expected that prisoners would have more oral disease and more use of illicit drugs than the general population. Additionally, this population was accessible and was not expected to be affected by socially-correct answers. Conducting the study within the confines of this particular penal institution restricted data collection to inmates evaluated by the staff dental hygienist and precluded using more than one examiner as well as conducting intra-examiner reliability tests.

The setting did allow for non-threatening, confidential and routine implementation of the personal interviews. The structure of the interview and sequencing of items were done to be consistent, clear, and easy to answer, to enhance recall and unbiased responses, and to give equal attention to all drugs. While self-reported information is often considered suspect, it is the most common methodology to obtain personal information and it is the most practical in terms of privacy and expense. Donovan concluded that self-reported drug use can be accurate if the foregoing techniques of interview design and implementation are utilized.⁴⁸

Future studies are needed to elucidate the role of methamphetamine use on oral health status. Large sample sizes are needed to study main effects regarding use of other drugs and to test the interaction effect regarding race/ethnicity found in this study among the small number (n=6) of Non-White users. Additional research using users and nonusers could test the validity of anecdotal information regarding the unique location and appearance of methamphetamine-associated caries. In addition to comparing users and nonusers, quantity and frequency of methamphetamine use and oral health should also be investigated. Another area of research would be to develop and test the effectiveness of interventions regarding oral hygiene, professional care, and soda consumption for methamphetamine users.

Conclusion

The effect of methamphetamine use on missing teeth was moderated by race/ethnicity; whereas the effect of methamphetamine use on dental caries was moderated by race/ethnicity and tooth brushing when on drugs. Methamphetamine use together with poor oral hygiene resulted in significantly more dental caries. As is evident from this study the relationship between methamphetamine use and oral health is complex. The findings from this study suggest that it may be possible to mitigate oral health problems associated with methamphetamine use through preventive oral hygiene programs. The avenues for further research stated above would add to the limited body of work on the relationship of methamphetamine use and oral health and would elucidate the role dental hygienists could play in reducing dental disease in methamphetamine users.

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References

1. Kraemer T, Maurer HH. Toxicokinetics of amphetamines: metabolism and toxicokinetic data of designer drugs, amphetamine, methamphetamine, and their N-alkyl derivatives. *Ther Drug Monit.* 2002;24(2):277-289.
2. Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration,. Treatment Episode Data Set (TEDS). In: Thompson N, ed. email ed. 2012: p. 1.
3. Governor's Office of Drug Control Policy. Iowa Drug Control Strategy. Des Moines, Iowa: Governor's Office of Drug Control Policy; 2013:58.
4. American Dental Association Division of Communications, Journal of the American Dental Association, American Dental Association Division of Scientific Affairs. For the dental patient ... methamphetamine use and oral health. *J Am Dent Assoc.* 2005;136(10):1491.
5. Mallat M. Meth mouth: a national scourge. *J Indiana Dent Assoc.* 2005;84(3):28-29.
6. Garcia-Godoy F, Hicks MJ. Maintaining the integrity of the enamel surface: the role of dental biofilm, saliva and preventive agents in enamel demineralization and remineralization. *J Am Dent Assoc.* 2008;139 Suppl:25s-34s.
7. Ravenel MC, Salinas CF, Marlow NM, et al. Methamphetamine abuse and oral health: a pilot study of "meth mouth". *Quintessence Int.* 2012;43(3):229-237.
8. Saini T, Edwards PC, Kimmes NS, et al. Etiology of xerostomia and dental caries among methamphetamine abusers. *Oral Health Prev Dent.* 2005;3(3):189-195.
9. Williams N, Covington JS, 3rd. Methamphetamine and meth mouth: an overview. *J Tenn Dent Assoc.* 2006;86(4):32-35.
10. Howe AM. Methamphetamine and childhood and adolescent caries. *Aust Dent J.* 1995;40(5):340.
11. Venker D. Crystal methamphetamine and the dental patient. *Iowa Dent J.* 1999;85(4):34.
12. Curtis EK. Meth mouth: a review of methamphetamine abuse and its oral manifestations. *Gen Dent.* 2006;54(2):125-129.
13. Donaldson M, Goodchild JH. Oral health of the methamphetamine abuser. *Am J Health Syst Pharm.* 2006;63(21):2078-2082.
14. Goodchild JH, Donaldson M. Methamphetamine abuse and dentistry: a review of the literature and presentation of a clinical case. *Quintessence Int.* 2007;38(7):583-590.
15. Goodchild JH, Donaldson M, Mangini DJ. Methamphetamine abuse and the impact on dental health. *Dent Today.* 2007;26(5):124,126,128-131.
16. Hamamoto DT, Rhodus NL. Methamphetamine abuse and dentistry. *Oral Dis.* 2009;15(1):27-37.
17. Heng CK, Badner VM, Schiop LA. Meth mouth. *N York State Dent J.* 2008;74(5):50-51.
18. Kessler B, Dinneen M. Methamphetamine: oral effects and treatment. *Inside Dent.* 2010;6(2):40,42,44,46,48.
19. Klasser GD, Epstein JB. The methamphetamine epidemic and dentistry. *Gen Dent.* 2006;54(6):431-439.
20. Naidoo S, Smit D. Methamphetamine abuse: a review of the literature and case report in a young male. *SADJ.* 2011;66(3):124-127.
21. Padilla R, Ritter AV. Meth mouth: methamphetamine and oral health. *J Esthetic Restor Dent.* 2008;20(2):148-149.
22. Rhodus NL, Little JW. Methamphetamine abuse and "meth mouth". *Northwest Dent.* 2005;84(5):29,31,33-27.
23. Shaner J. Caries associated with methamphetamine abuse. *J Mich Dent Assoc.* 2002;84(9):42-47.
24. Shaner JW, Kimmes N, Saini T, Edwards P. "Meth mouth": rampant caries in methamphetamine abusers. *AIDS Patient Care STDS.* 2006;20(3):146-150.
25. Turkyllmaz I. Oral manifestations of "meth mouth;": a case report. *J Contemp Contemp Dent Pract.* 2010;11(1):E073-E080.

26. Chi D, Milgrom P. The oral health of homeless adolescents and young adults and determinants of oral health: preliminary findings. *Spec Care Dentist*. 2008;28(6):237-242.
27. Laslett AM, Dietze P, Dwyer R. The oral health of street-recruited injecting drug users: prevalence and correlates of problems. *Addiction*. 2008;103(11):1821-1825.
28. McGrath C, Chan B. Oral health sensations associated with illicit drug abuse. *Br Dent J*. 2005;198(3):159-162.
29. Walter A, Bachman SS, Reznik DA, et al. Methamphetamine use and dental problems among adults enrolled in a program to increase access to oral health services for people living with HIV/AIDS. *Public Health Rep*. 2012;127(Suppl 2):25-35.
30. Brown C, Krishnan S, Hursh K, et al. Dental disease prevalence among methamphetamine and heroin users in an urban setting: a pilot study. *J Am Dent Assoc*. 2012;143(9):992-1001.
31. Cretzmeyer M, Walker J, Hall JA, Arndt S. Methamphetamine use and dental disease: results of a pilot study. *J Dent Child (Chic)*. 2007;74(2):85-92.
32. Morio KA, Marshall TA, Qian F, Morgan TA. Comparing diet, oral hygiene and caries status of adult methamphetamine users and nonusers: a pilot study. *J Am Dent Assoc*. 2008;139(2):171-176.
33. Shetty V, Mooney LJ, Zigler CM, et al. The relationship between methamphetamine use and increased dental disease. *J Am Dent Assoc*. 2010;141(3):307-318.
34. Marshall BD, Werb D. Health outcomes associated with methamphetamine use among young people: a systematic review. *Addiction*. 2010;105(6):991-1002.
35. Klugh H. *Statistics: the essentials for research*. Hillsdale, NJ: Erlbaum Associates Inc. 1986: p. 257.
36. Tabachnick BG, Fidell LS. *Using multivariate statistics*. 5th ed. San Francisco, CA: Pearson:Allyn & Bacon. 2007.
37. Akaike H. A new look at the statistical model identification. *IEEE Trans Automatic Contr*. 1974;19(6):716-723.
38. Kleinbaum D. *Applied Regressive Analysis and other multivariate variable methods*. 1st ed. New York: Duxbury Press; 1998.
39. Bailit HL, Braun R, Maryniuk GA, Camp P. Is periodontal disease the primary cause of tooth extraction in adults? *J Am Dent Assoc*. 1987;114(1):40-45.
40. Department of Health and Human Services. 2005 National Survey on Drug Use and Health: National Findings. In: SAMSHA, ed: DHHS; 2006.
41. Astrom AN, Jakobsen R. Stability of dental health behavior: a 3-year prospective cohort study of 15-, 16- and 18-year-old Norwegian adolescents. *Community Dent Oral Epidemiol*. 1998;26(2):129-138.
42. Blinkhorn AS. Dental preventive advice for pregnant and nursing mothers--sociological implications. *Int Dent J*. 1981;31(1):14-22.
43. Honkala E. Oral health. In: Schou L, Blinkhorn AS, ed. *Oral health promotion*. Oxford, NY: Oxford Univeristy Press. 1993.
44. Tolvanen M, Lahti S, Poutanen R, et al. Children's oral health-related behaviors: individual stability and stage transitions. *Community Dent Oral Epidemiol*. 2010;38(5):445-452.
45. Traeen B, Rise J. Dental health behaviours in a Norwegian population. *Community Dent Health*. 1990;7(1):59-68.
46. Osborn M, Butler T, Barnard PD. Oral health status of prison inmates--New South Wales, Australia. *Aust Dent J*. 2003;48(1):34-38.
47. Salive ME, Carolla JM, Brewer TF. Dental health of male inmates in a state prison system. *J Public Health Dent*. 1989;49(2):83-86.
48. Donovan DM, Bigelow GE, Brigham GS, et al. Primary outcome indices in illicit drug dependence treatment research: systematic approach to selection and measurement of drug use end-points in clinical trials. *Addiction*. 2012;107(4):694-708.

Knowledge and Behaviors Regarding Early Childhood Caries Among Low-Income Women in Florida: A Pilot Study

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Introduction

Dental caries is the most prevalent and untreated chronic disease of children in the U.S.¹ Early childhood caries (ECC), formerly known as baby bottle decay, affects the primary dentition of those less than 72 months of age, and currently children ages 2 to 5 have approximately 30% untreated dental decay.^{2,3} It is estimated that 17 million low-income children received no dental care in 2009.⁴ Dental caries is prevalent in children from low-income households and minority populations.^{1,4}

ECC is a major public health problem, and if left untreated can cause pain, infection and swelling from abscess, eating problems, and esthetic concerns.¹⁻⁴ Untreated dental caries can lead to loss of school time, learning difficulties, impaired nutrition and health, and in severe cases can result in life-threatening infection.³ Each year children miss 51 million hours of school due to dental related problems.⁴ Hospitalization for treatment under general anesthesia is most often necessary to treat severe ECC.³

Major risk factors for ECC are minority racial status and low family income, poor access to dental care, and mothers' poor knowledge about the importance of oral health.^{1,5} Poor oral health behaviors of the mothers and their young children are also factors in developing ECC.⁶ Frequent exposures to sweetened drinks and milk in baby bottles and sippy cups, as well as nursing during sleep have been linked to the development of severe ECC.⁷ Studies find that ECC can have an overall negative effect on the oral health related quality of life of preschool children.⁸ Toddlers affected by ECC tend to grow slower than caries-free toddlers, may be underweight due to difficulty eating and are more likely to have dental problems as adults.⁹

Abstract

Purpose: This study evaluated the oral health knowledge and behaviors in pregnant women and mothers of young children in relation to early childhood caries to assess the need for an educational oral health program.

Methods: Interviews were conducted from a sample of 103 Medicaid-eligible participants; 56 pregnant women and 47 mothers with children under the age 6 in Florida. The data were collected using a 4-page questionnaire with closed-ended questions and analyzed using SAS/STAT 9.22.

Results: Overall, 79 of 101 study participants (78%) did not receive any dental care during pregnancy. There was a significant relationship between the frequencies of mother's tooth brushing and how frequently toddlers' teeth were brushed ($C=0.29$; $p=0.04$), and the mothers' self-reported oral health ratings and how frequently they brushed their toddlers' teeth ($r^2=0.29$; $p=0.03$).

Conclusion: Mothers' oral hygiene habits are significantly related to the oral hygiene habits of their children. Oral health education, during and after pregnancy, would be beneficial to promote healthier mouths for the mothers and their children.

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

Since ECC is prevalent among children between 2 to 5 years old of low socioeconomic status,¹⁰ a special supplemental nutrition program for Women, Infants and Children (WIC) can provide a target group for preventive dental services. WIC programs are offered through county health departments and provide nutritious foods, nutritional counseling and referrals to health care and social services to low-income pregnant, postpartum and breastfeeding women, as well as children up to age of 5.¹⁰ Studies find that oral health literacy levels in WIC mothers are a significant factor in the oral health of their children.^{11,12} Investigators report that children who seek preventive dental care at an early age have fewer dental problems as children and are more likely to continue the utilization of preventive care in the future.^{13,14} New mothers who lack knowledge about oral health and proper oral hygiene are more

likely to have young children with ECC than new moms with better dental hygiene habits and oral health knowledge.¹⁵

Many women are also unaware of the effects of their oral health behavior on themselves and their babies prior to, during and after pregnancy.¹⁶ Although dental care during pregnancy is safe and can prevent long-term health problems for both mother and child, many women do not seek dental care during pregnancy and many dentists are uncomfortable treating pregnant patients.¹⁷⁻²³ Shortage of dental providers for Medicaid populations is among the challenges concerning dental care for mothers and pregnant women. Other challenges include state budget cuts to Medicaid dental programs, fewer dentists having experience with Medicaid population and pregnant women, no-show rates, and low reimbursements and scope of dental coverage.²⁰ Oral diseases may affect the health of a woman and an unborn child.¹⁸ Although the Seminole County Health Department offers full dental services free of charge to Medicaid recipients up to age 21, it is important to understand the behavior and knowledge of Medicaid-eligible patients in relation to dental caries to promote preventive dental care and reduce the need for future treatment.

The purpose of this study was to evaluate the oral health knowledge and behaviors among Medicaid-eligible pregnant women and mothers of young children in relation to early childhood caries, and to assess the need for an educational oral health program in Seminole County Health Department clinics in Florida.

Methods and Materials

Subjects

This study was approved by an A. T. Still University Institutional Review Board. Study subjects were recruited from 3 separate departments: pre-natal clinic, the primary clinic and the WIC's mandatory breastfeeding classes at the Seminole County Health Department in Florida. Informed consent was obtained from participants who filled out the study survey. Inclusion criteria were pregnant women and mothers of children under age 6, enrolled in the WIC program, and were enrolled in Medicaid or Medicaid eligible. Women were approached by the researcher in the clinics and asked to participate in the study. The exclusion criteria were participants with private dental insurance, had children older than 6 or did not qualify for government assisted programs or Medicaid. At baseline, there were 103 participants, 56 pregnant women and 47 non-pregnant mothers, with 55 of the women with children under age 6.

Data Collection

The data for this study was collected using a 4-page questionnaire in paper format with closed-ended questions administered to pregnant women and mothers (n=101) of children under the age of 6. Pregnant, first time mothers were given a questionnaire regarding their own oral health and mothers of children under age 6 were given an additional survey about their children's oral health. The questionnaire was modified from other oral health questionnaires used for similar studies.²⁴ No personal identifying information was collected. Since all women were in low SES and educational level in this clinic, education was not indicated as an important additional variable to be included. There was no compensation for participating in this survey. The information collected was about parents' oral health knowledge, attitudes, behaviors and beliefs. The questionnaire also evaluated the child's diet, frequency of dental visits and bottle-feeding habits. To assess oral health behavior of the mothers, participants were asked to select answers to behavior-related items, such as: "How often do you brush your teeth?" and "How often do you receive routine dental care?" Response items included "once per day," "twice per day," "a few times per week" and "never." Similar questions were asked to assess oral health behavior of the toddlers, such as: "How often do you brush your toddler's teeth?" or "How often does your toddler receive routine dental care?" Similar response items are reported in Table I. After completion of the oral health questionnaires, participants were provided oral hygiene education and material. Referrals to participating adult Medicaid dental homes were also available upon request.

Data Analysis

Data from the questionnaire were evaluated using SAS 9.3. Mantel-Haenszel chi-square statistics were used to determine the relationship between mothers' oral health behavior and children's oral health behavior using mid-ranks. Associations were considered statistically significant at $p < 0.05$.

Results

All women who consented to this survey were interviewed. A sample of 103 participants completed the questionnaires but only 101 questionnaires were included in analysis. Incomplete questionnaires (n=2) were removed from the analysis. Most of the participants were 21 to 30 years of age (65%). Distribution of the age of the participants is presented in the Table II. There were 56 pregnant participants (55%) at the time of the study, but

only 22 participants (22%) had a dental visit during pregnancy. Fifty-five mothers (54%) had children under the age of 6. In total, 79 participants (78%) did not receive dental care during pregnancy. Multiple reasons were given for not having dental visits during pregnancy, which included: "did not have dental pain or problems" (27%), "no insurance" (14%), "inability to pay" (5%), "were told not to go to the dentist"(8%), "were afraid of the dentist" (9%) or "could not find a dentist who treated pregnant patients" (8%). Over half of the participants (53%) did not provide a reason for not visiting a dentist during pregnancy (Figure 1).

Of all participants (n=101), only 7 rated their oral health as excellent (7%), 51 as good (50%), 34 as fair (34%) and 9 rated their oral health as poor (9%). Over half of mothers (58%) reported to brush their teeth 2 or more times per day, with fewer than 30% using dental floss once per day (Table I). There was a significant correlation ($r^2=0.27$; $p=0.008$) between how the mothers rated their oral health and how often they brushed their teeth. Mother's reported oral health was significantly positively associated with the reported flossing ($r^2=0.35$; $p<0.001$), and there was a significant correlation between mother's perceived oral health and the frequency of their dental visits ($r^2=0.32$; $p=0.002$).

The questions regarding the children's oral health habits included the frequency of brushing and dental visits, as well as the toddler's bottle contents. Twenty-four out of 51 mothers (47%) reported to brush their toddler's teeth twice per day, 20 mothers brushed once a day (39%), 5 few times a week (10%) and only 2 mothers never brushed their toddler's teeth (4%). There was a significant positive relationship between a mother's teeth-brushing frequency and the teeth-brushing frequency of the toddler performed by the mother ($r^2=0.29$; $p=0.04$). There was a significant positive relationship between the mother's self-reported oral health rating and the teeth-brushing frequency given by the mother to the toddler ($r^2=0.29$; $p=0.03$).

Although 46 (90%) mothers with children under age 6 responded that it is important for toddlers to receive routine dental check-ups, only 14 (27%) admitted that their toddlers receive routine dental check-ups 2 times a year. Mothers who reported their oral health as fair or poor corresponded to brushing their toddler's teeth less frequently.

In response to questions regarding bottle-feeding and its contents, the majority of mothers (42, 82%) reported that they do not put their children to bed with a bottle. Of the mothers that respond-

Table I: Caregivers' Oral Health Characteristics and Behavior

Caregiver	Frequency Numbers (n=101)	Frequency Percent
Oral Health		
<ul style="list-style-type: none"> • Excellent • Good • Fair • Poor 	7 51 34 9	6.93% 50.50% 33.66% 8.91%
Brushing Frequency		
<ul style="list-style-type: none"> • A few times per week • About once a day • Two or more times per day 	4 38 60	3.96% 37.62% 59.41%
Flossing Frequency		
<ul style="list-style-type: none"> • Never • Less than once per week • Once to six times per week 	23 50 27	22.77% 49.50% 26.73%
Mouthwash and Dental Rinse Frequency		
<ul style="list-style-type: none"> • Never • Less than once per week • Once to six times per week • At least once per day 	15 28 27 29	14.85% 27.72% 26.73% 28.71%
Routine Dental Care		
<ul style="list-style-type: none"> • Never • Less than once per year • Once per year • Two or more times per year • Only when experiencing dental problem 	13 25 21 17 21	12.87% 24.75% 20.79% 16.83% 20.79%
Dental Care During Pregnancy		
<ul style="list-style-type: none"> • Yes • No 	22 79	21.78% 78.22%
*If Not, Why?		
<ul style="list-style-type: none"> • I was not having dental problems • I do not have dental insurance • I can't afford to go to the dentist • I was told not to go to the dentist during pregnancy • I am afraid to go to the dentist • I can't find a dentist who treats pregnant women • No reason 	27 14 5 8 9 8 53	26.73% 13.86% 4.95% 7.92% 8.91% 7.92% 52.48%

*Multiple answers were selected by participants

ed to bottle-feeding during the day, 43 selected multiple answers. The liquid of choice selected for bottle feeding during the day included: water (29, 67%), milk (28, 65%) and juice (23, 53%).

Bivariate association between the mothers' oral health rating, the frequency of tooth brushing and the frequency of tooth brushing of their toddlers showed a significant positive association. Mothers who rated their oral health as good or excellent brushed and flossed their teeth and their toddler's teeth more frequently than mothers that rated their oral health as fair or poor. The frequency of mothers' brushing, flossing, mouthwash use and dental visits showed a positive correlation with the self-reported oral health rating ($r^2=0.39$; $p<0.001$).

Discussion

The oral health of infants and toddlers is dependent on mothers' knowledge of oral health and oral hygiene behavior.⁶ In 2000, the Surgeon General's Report on Oral Health in America stressed it was necessary for parents to be familiar with the importance and care of children's primary teeth, and to take appropriate actions to prevent ECC.²⁵

The primary finding of this study was that the mothers' oral hygiene habits and frequency of dental visits are significantly related to the oral hygiene habits and frequency of dental visits of toddlers. Studies show that perception of oral health is of higher level than perception of oral disease which can influence a person's behavior to seek dental care.^{26,27} Questionnaires regarding pregnant woman and mothers of young children can show the level of dental and oral health awareness.^{26,27} This study found a positive correlation between the self-perceived oral health of mothers and their oral hygiene habits. This study supports the findings of a prior study that poor oral health behaviors can be contributing factors to poor oral health in adults and their children.⁶ Good oral health behavior is dependent on individual's understanding of oral health and their ability to act on the information.¹¹ It has been shown that frequent use of dental care can provide higher knowledge of oral health for this population.¹¹ Studies conducted on the effectiveness of motivational interviewing with regular reinforcements of dental caries prevention in pregnant mothers and mothers of infants, has shown promise in reducing early childhood decay by the time children reached age 2 years.^{25,28,29} Thus, oral health education of WIC participants designated to cater to patients with a lower level of oral health literacy is an important factor to prevent ECC. It has been shown that children whose mothers emphasize oral health have fewer cavities

Table II: Age Distribution of Participants

Age	n=101	Percent
Under18	4	3.96%
18 to 20	16	15.84%
21 to 25	30	29.70%
26 to 30	35	34.65%
31 to 35	5	4.95%
36 and older	11	10.90%

than children without proper oral hygiene habits at home.^{6,15} Because parents are responsible for the oral hygiene habits and diet of young children at home, parental knowledge of oral health and oral hygiene habits are of great importance.⁶

Oral health knowledge, attitudes and behaviors of Medicaid parents largely affect their use of preventive dental care.³⁰ Although these parents believe it is important for toddlers to receive dental care, they may not place high value on receiving preventive care. Studies suggest that the rate of no-shows or missed appointments among Medicaid patients is a large contributing factor to lack of Medicaid dental providers.^{14,20} Many Medicaid participants equate lack of dental pain to a healthy mouth and do not seek care unless treatment is needed for immediate pain relief.¹⁴ Another contributing factor for lack of dental care utilization may be the shortage of Medicaid providers in the area.^{20,21} Poor access to dental care, knowledge and behavior of mothers, as well as consumption of sugary drinks in the first few years of life, are contributing factors to ECC in Medicaid children.^{6,12,14,15,19}

Early preventive visits are more effective in children at higher risk, and because children of Medicaid and WIC are at higher risk for ECC, promoting early visits should be practiced by WIC staff or pediatric Medicaid healthcare physicians.^{11,24} Prevention of ECC can be provided by promoting good oral hygiene habits, good nutrition, establishing of a dental home at an early age and preventive practices such as applications of fluoride by health professionals.¹³ Prenatal and postpartum counseling of mothers on oral health is necessary to promote healthy dental behaviors that continue into the adulthood of Medicaid-enrolled children. Also promoting dental care for pregnant women is important due to the strong relationship between oral health status of the mother and child.

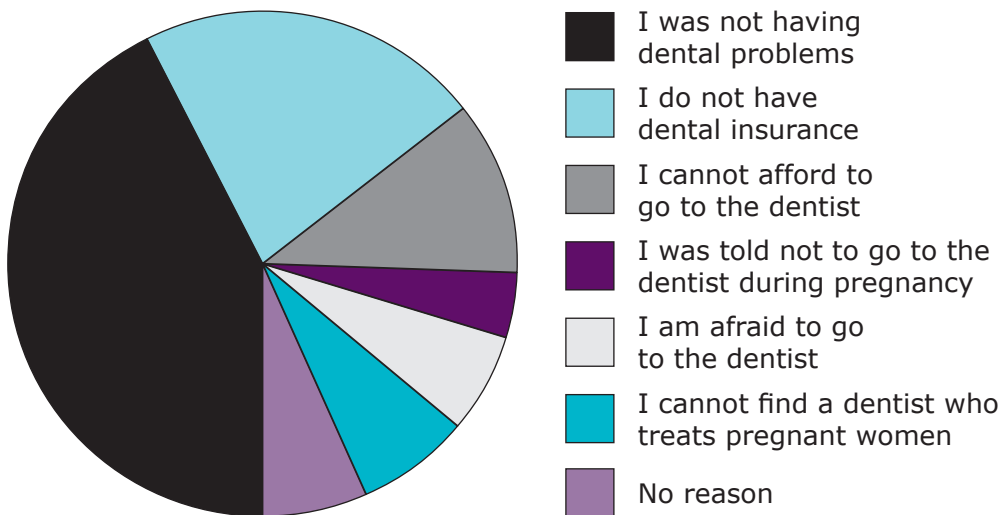
The limitation of this study is that participants were selected from 1 public health department in 1 state and only English speaking caregivers completed the questionnaire. Because ECC is affected

by many different social and environmental risk factors, this survey may not be a predictor of all Medicaid and WIC participants.¹⁴ Other limitations of this survey were the possible volunteer bias since women participated voluntarily and a relatively small sample size. Our study sample was a convenience sample from 1 clinic consisting self-reported data, which was not confirmed by clinical data. This study is the first oral health study of Seminole County WIC participants and its results can be used to evaluate the need for preventive dental program for this population. Further research is necessary to better understand the factors related to oral health of children and women enrolled in the WIC programs.

Conclusion

This study reports that mothers' oral hygiene habits were related to the oral hygiene habits of their children, and many pregnant women do not have dental care during their pregnancies. These results support the need for preventive oral health education program for pregnant women and mothers of young children. However, oral health education alone may not be effective enough so including other preventive approaches, such as fluoride varnish applications, and finding a dental home is important in reducing disease burden in low-income risk populations. A comprehensive preventive approach and an inter-professional collaboration with other health care professionals could be the future model to help improve oral health of this vulnerable population.

Figure 1: Reasons for Not Receiving Routine Dental Care During Pregnancy



*Multiple answers were selected by participants

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References

1. Bader JD, Rozier RG, Lohr KN, Frame PS. Physicians' roles in preventing dental caries in preschool children: a summary of the evidence for the U.S. preventive services task force. *Am J Prev Med.* 2004;26(4):315-325.
2. Definition of early childhood caries (ECC). American Academy of Pediatric Dentistry [Internet]. 2003 [cited 2015 March 27]. Available from: http://www.aapd.org/assets/1/7/D_ECC.pdf
3. The Cost of Delay State Dental Policies Fail One in Five Children. Pew Center on the States [Internet]. [cited 2012 September 11]. Available from: "http://www.pewtrusts.org/uploaded-Files/Cost_of_Delay_web.pdf
4. Edelstein LB. The cost of caring: Emergency oral health services [Policy brief]. National Center for Education in Maternal and Child Health [Internet]. 1998 [cited 2012 October 11]. Available from: "http://www.hawaii.edu/hivandaids/The_Cost_Of_Caring__Emergency_Oral_Health_Services.pdf
5. Tomar SL, Reeves AF. Changes in the oral health of US children and adolescents and dental public health infrastructure since the release of the Healthy People 2010 Objectives. *Acad Pediatr.* 2009;9(6):388-395.
6. Vann WF Jr, Lee JY, Baker D, Divaris K. Oral health literacy among female caregivers: impact on the oral health outcomes in early childhood. *J Dent Res.* 2010;89(12):1395-1400.
7. Ismail AI, Sohn W. A systematic review of clinical diagnostic criteria of early childhood caries. *J Public Health Dent.* 1999;59(3):171-191.
8. Martins-Júnior PA, Vieira-Andrade RG, Corrêa-Faria P, Oliveira-Ferreira F, Marques LS, Ramos-Jorge ML. Impact of Early Childhood Caries on the Oral Health-Related Quality of Life of Preschool Children and Their Parents. *Caries Res.* 2013;47(3):211-218.
9. Caufield PW. Caries in the primary dentition: a spectrum disease of multifactorial etiology. American Dental Association [Internet]. 2010 [2013 April 20]. Available from: http://www.ada.org/sections/newsAndEvents/pdfs/01_caries_in_primary_dentitions-caufield_b.pdf
10. Food and Nutrition Service. About WIC. United States Department of Agriculture. 2013.
11. Weber-Gasparoni K, Goebel BM, Drake DR, et al. Factors associated with mutans streptococci among young WIC-enrolled children. *J Public Health Dent.* 2012;72(4):269-278.
12. Lee JY, Divaris K, Baker AD, Rozier RG, Lee SY, Vann WF Jr. Oral health literacy levels among a low-income WIC population. *J Public Health Dent.* 2011;71(2):152-160.
13. Hale KJ, American Academy of Pediatrics Section on Pediatric Dentistry. Oral health risk assessment timing and establishment of the dental home. *Pediatrics.* 2003;111(5):1113-1116.
14. Bugis BA. Early childhood caries and the impact of current U.S. Medicaid program: an overview. *Int J Dent.* 2012;2012:348237.
15. Mohebbi SZ, Virtanen JI, Vehkalahti MM. A community-randomized controlled trial against sugary snacking among infants and toddlers. *Community Dent Oral Epidemiol.* 2012;40(Suppl 1):43-48.
16. D'Angelo D, Williams L, Morrow B, et al. Preconception and interconception health status of women who recently gave birth to a live-born infant. Pregnancy Risk Assessment Monitoring System (PRAMS), United States, 26 Reporting Areas, 2004. *MMWR Surveill Summ.* 2007;56(10):1-35.
17. Improving the oral health of pregnant women and young children: opportunities for policymakers. National Maternal and Child Oral Health Policy Center [Internet]. 2012 [cited 2013 May 26]. Available from: <http://nmcohpc.net/2012/improving-oral-health-pregnant-women>
18. Marchi KS, Fisher-Owen SA, Weintraub JA, Yu Z, Braveman PA. Most pregnant women in California do not receive dental care: findings from a population-based study. *Public Health Rep.* 2010;125(6):831-842.
19. Gaffield ML, Gilbert BJ, Malvitz DM, Romaguera R. Oral health during pregnancy: an analysis of information collected by the pregnancy risk assessment monitoring system. *J Am Dent Assoc.* 2001;132(7):1009-1016.

20. Findings of the National Maternal & Child Oral Health Policy Center Focus Group Convened in Conjunction with the National Academy for State Health Policy Annual Conference. National Maternal and Child Oral Health Policy Center [Internet]. 2010 October 6 [cited 2015 March 27]. Available from: <http://nmcohpc.net/resources/NASHP%20Focus%20Group%20Summary%20Final.pdf>
21. Keirse MJ, Plutzer K. Women's attitudes to and perceptions of oral health and dental care during pregnancy. *J Perinat Med*. 2010;38(1):3-8.
22. Kloetzel MK, Huebner CE, Milgrom, P. Referrals for dental care during pregnancy. *J Midwifery Womens Health*. 2011;56(2):110-117.
23. American Academy of Pediatric Dentistry Council on Clinical Affairs, Committee on the Adolescent. Guideline on oral health care for the pregnant and adolescent. *Pediatr Dent*. 2012;34(5):153-159
24. Harrison R, Benton T, Everson-Stewart S, Weinstein P. Effect of motivational interviewing on rates of early childhood caries: a randomized trial. *Pediatr Dent*. 2007;29(1):16-22.
25. Oral health in America: a report of the Surgeon General. U.S. Department of Health and Human Services, Public Health Service, National Institute of Dental and Craniofacial Research. 2000.
26. Vered Y, Sgan-Cohen HD. Self – perceived and clinically diagnosed dental and periodontal health status among young adults and their implications for epidemiological surveys. *BMC Oral Health*. 2003;3(1):3.
27. Balappanavar AY, Sardana V, Nagesh L, Ankola AV, Kakodkar P, Hebbal M. Questionnaire vs clinical surveys: the right choice?--A cross-sectional comparative study. *Indian J Dent Res*. 2011;22(3):494.
28. Weinstein P, Harrison R, Benton T. Motivating mothers to prevent caries: confirming the beneficial effect of counselling. *J Am Dent Assoc*. 2006;137(6):789-793.
29. Prochaska JO, DiClemente CC. Stages of change in the modification of problem behaviors. *Prog Behav Modif*. 1992;28:183-218.
30. Grembowski D, Spiekerman C, Milgrom P. Linking mother access to dental care and child oral health. *Comm Dent Oral Epidemiol*. 2009;37(5):381-90