



American  
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Hygienists'  
Association

# JOURNAL OF DENTAL HYGIENE

THE AMERICAN DENTAL HYGIENISTS' ASSOCIATION

FEBRUARY 2018 • VOLUME 92 • NUMBER 1

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- Engaging Stakeholders in Patient-Centered Outcomes Research Regarding School-Based Sealant Programs
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The Journal of Dental Hygiene is the refereed, scientific publication of the American Dental Hygienists' Association. The JDH promotes the publication of original research related to the profession, education, and practice of dental hygiene and 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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## What does research tell us about the future of dental hygiene?

Jacquelyn L. Fried, RDH, MS

When I was asked to write an editorial on what research tells us about the future of dental hygiene, my immediate thought was – it pretty much tells us everything! My mind started racing as I pondered the topic and what seemed like a million ideas ran through my head. My attempt here is to consider selected current trends and scientific data that speak to some of the salient issues that will affect the future of our profession.

Research findings allow the dental hygiene profession to keep pace with current demographic, political, economic, psychosocial, technological, physiological and educational changes occurring in our society. These changes, or forces, shape health care delivery in the U.S. and directly affect our future. Many trends offer pathways for professional acceleration while others suggest challenges we must address. Our profession's future rests upon acknowledging research results derived from well-conducted scientific studies and proceeding accordingly. One can hardly deny that the future of health care is growing in complexity. These complexities mandate that dental hygienists possess well-developed and multi-faceted skill sets, commanding high levels of formal education.

Epidemiologic data shows a burgeoning elderly cohort, a more heterogeneous society and a large population segment lacking access to cost-effective, quality oral health care. What does this mean for the future of dental hygiene? First, dental hygienists must be equipped to manage patients with poly-pharmacy, understand the oral and systemic effects of medications and be able to convey this information to their clients and to other health and human service providers. Knowledge of the oral-systemic link as related to specific medical conditions is essential. The level of disease among the in-patient elderly, the dearth of available preventive care and research data demonstrating that oral disease is a

primary cause of nosocomial pneumonia all suggest that dental hygienists will assume more prominent roles in assisted living, long term care and hospital facilities.<sup>1</sup> This prominence will demand interprofessional collaborative, leadership and administrative skills.

Delivering care in a heterogeneous society and treating those with limited access occurs in many delivery settings. In each setting, the dental hygienist will need expertise in the delivery of culturally competent care, recognizing limited and low health literacy challenges while demonstrating outstanding communication and leadership skills. In some culturally indigenous facilities, the dental hygienist is the primary oral health care gatekeeper.<sup>2</sup> Dental hygienists may be the only oral health care providers available in some rural health care settings.<sup>3</sup> Dental hygienists will also assume important preventive roles in federally qualified health care facilities. Telehealth will become more commonplace as dental hygienists practice in settings requiring distance and digital communication. To reduce the growing rate of oral-related hospital emergency visits among underserved and disenfranchised populations, preventive care has become a number one priority. In the area of early intervention, assisting in risk assessment and providing dental homes for children who would otherwise not have access to dental care, the presence of dental hygienists in pediatric medical practices has shown promise and will likely grow.

Economic and political findings will influence the future of the profession. Legislative changes addressing scope of practice, federal mandates such as the Affordable Care Act and politicians' growing awareness of the cost of untreated health care will catapult the profession into greater prominence. Economically, fewer dentists are opening solo practices. Research indicates that large group practices are growing exponentially with some settings blending the delivery of medical and dental services.<sup>4</sup> The practice of "dental medicine" will grow. In many of these delivery settings, dental hygienists will serve as administrators and must have a strong knowledge base in the oral systemic link, interprofessional collaboration and technological skills related to chairside testing and information sharing and management.

Future dental hygienists must be students of cultural change. Psychosocially, we are seeing changes and greater acceptance of sexual orientations and preferences. With an increase in HPV-associated head and neck cancers through salivary diagnostics dental hygienists will be more involved with disease identification and the provision of related preventive education. Dental hygienists will likely play an increased role in sophisticated chairside testing



that will help identify oral diseases and other systemic conditions. This same technology also allows for the identification of genetic biomarkers associated with specific diseases. Molecular biological research and genomic information will guide future practice and advance the understanding of cranio-facial diseases, including dental caries and periodontal disease.<sup>5</sup>

Dental hygiene is poised to identify societal diseases of documented epidemic proportions. Many dental hygienists already conduct rapid HIV testing. Using this same model, future dental hygienists will perform rapid glucose testing for diabetes and in addition to discussing periodontal disease, will educate patients about obesity and the role sugar plays in both oral *and* systemic disease. Screening for high blood pressure, "the silent killer," is standard of care in most educational institutions and will become commonplace in all practice settings.

Research in the area of education offers telling findings. First, dental hygiene curricula will be emphasizing interprofessional education as supported by national data.<sup>6</sup> Secondly, amassed data show that dental hygiene faculty pools are aging and a crisis of qualified educators looms.<sup>7</sup> Who will teach the future students?

Since new research findings are generated constantly, dental hygiene professionals must be astute consumers of the literature and ever cognizant of the evolving health care world around them. Dental hygiene educators who are in the forefront of shaping the future workforce must base their curricula on new, valid and reliable scientific information.

Most importantly, dental hygiene must have its own body of research. In essence, we must conduct the studies that demonstrate our worth. The data emanating from the dental therapy studies is a classic example of documented success. Outcomes data show that Minnesota Advanced Dental Therapists (ADT) are creating change and reducing oral disease, and that ADTs are well-accepted and garner a high level of patient satisfaction.<sup>8</sup> More dental hygiene research must provide the data demonstrating our value to the communities we serve.

We cannot afford to be the best kept secret any longer. We need standardized, valid and reliable outcomes measures demonstrating the evidence on how we prevent disease, promote health and contribute to the overall well-being of society - this is the real research that will shape our future.

In essence, we need to put our data where our mouths are!

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# RESEARCH

## A Study of Visible Tattoos in Entry-Level Dental Hygiene Education Programs

Kathryn R. Search RDH, MS; Susan L. Tolle, RDH, MS; Gayle B. McCombs, RDH, MS; Aaron Arndt, PhD

### Abstract

**Purpose:** The purpose of this study was to survey entry-level dental hygiene program directors in the United States (U.S.) to assess their perceptions of dental hygienists with visible tattoos as well as to determine current policies related to dress codes in U.S. dental hygiene programs.

**Methods:** Data was collected with an online survey emailed to 340 dental hygiene program directors yielding a 43% (n=141) response rate. Participants indicated their opinions of visible tattoos on the basis of professionalism and school policy satisfaction.

**Results:** Eighty percent of respondents reported their program as having dress code policies on visible tattoos, with the majority (97%) requiring visible tattoos to be covered. Results revealed both students (M=5.57,  $p < .0005$ ) and faculty (M=5.76,  $p < .0005$ ) with visible tattoos were perceived as significantly less professional. Most participants agreed that dental hygiene faculty should discuss the impact of visible tattoos on future employment opportunities, and that the community would view the school as less professional if students had visible tattoos ( $p < .0005$ ). Personal tolerance toward tattoos ( $p < .001$ ), but not age, ( $p = 0.50$ ), was significantly associated with satisfaction concerning program tattoo policies. A lower tolerance towards visible tattoos ( $p < .001$ ) was associated with an increased likelihood that the dental hygiene program dress code included policy on visible tattoos.

**Conclusion:** Study results showed that visible tattoos were not perceived favorably and that personal perceptions of dental hygiene program directors may have influenced school dress code policies regarding visible tattoos. These findings provide evidence based information for dental hygienists, students, faculty, administrators and hiring managers for formulating policies relating to body art.

**Keywords:** professionalism, dental hygiene, dental hygiene education, health care dress codes, tattoos, body art

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### Introduction

Dental hygiene programs are required to make important decisions about appearance and dress code policies relating to both faculty and students. A contemporary aspect of professional appearance in healthcare is the presence of visible tattoos.<sup>1-3</sup> Tattooing has increased in popularity among all ages, socioeconomic groups and professions, while also crossing gender, social class, and racial barriers.<sup>4,5</sup> National polling indicates that three in ten United States (U.S.) adults have a tattoo,<sup>6</sup> yet negative stereotyping of individuals displaying tattoos is a well-documented cultural norm.<sup>5,7</sup> Surveys indicate that approximately 40% of adults aged 18-40 and 30% of the younger generation have visible tattoos.<sup>8-9</sup> This once unorthodox practice is commonly perceived as mainstream in today's society, especially among the

millennial generation.<sup>5,10-12</sup> However, older Americans are more likely to view tattooing negatively, with 64% of persons over the age of 65 viewing current tattoo trends as a change for the worse.<sup>13</sup>

Despite their increased prevalence, visible tattoos in the professional work environment are often viewed as inappropriate and unprofessional.<sup>1,3,14-15</sup> Negative stereotypes are predominant especially in fields that emphasize appropriate appearance, and research suggests individuals with visible tattoos are perceived as less intelligent, professional, approachable, trustworthy, and kind.<sup>1,14,16-17</sup> These negative stereotypes have the potential to impact the patient /health care provider relationship as well as the student/faculty relationship.<sup>17</sup> For example, if patients associate tattoos with negative stereotypes, they may expect the work performance of the health

care provider to be less satisfactory. Moreover, these negative perceptions have the potential to negatively impact the overall professional image of the provider and be generalized to the particular health care profession. Patient satisfaction is a valued commodity in all health care settings. Patient dissatisfaction, whether based on perceived treatment issues or clinician appearance, could impact business as well as patient's adherence to treatment recommendations and outcomes.<sup>17</sup>

Appearance is a powerful aspect of non-verbal interactions and is considered an essential mode of communication.<sup>1,17-20</sup> Brosky and colleagues found that patients' first impressions of both dental students and faculty affected the comfort and anxiety levels of patients and the clinician's appearance influenced patients' perceptions of professionalism.<sup>18</sup> Physical appearance was shown to influence the professional image of health care providers and visible tattoos have been reported to diminish professional image and credibility.<sup>1,16,17-19</sup> LaSala and Nelson advocate even though various settings require specific dress protocols, professional nurses should consistently be "sensitive to the image presented" and question whether visible tattoos plays a role in this sensitivity.<sup>19</sup>

Limited research on individuals' perceptions of health care workers with visible tattoos is available to date. However, research findings reported in the nursing literature suggests patients often hold negative perceptions of health care providers with visible tattoos.<sup>1,3,16</sup> Westerfield et al. surveyed patients to determine their perceptions of nurses with visible tattoos and found that hospitalized patients perceived that nurses without visible tattoos were more caring, confident, reliable, attentive, cooperative, professional, efficient, and approachable when compared to nurse providers with visible tattoos.<sup>16</sup> Results also suggest that women with visible tattoos were perceived as less professional than their male counterparts indicating a possible gender bias in the perception of nurses with tattoos.<sup>16</sup> Similar results on gender were reported by Boultinghouse who found that female nurses with visible tattoos were perceived to be less trustworthy and kind compared to female nurses without tattoos, although male nurses with and without visible tattoos were rated the same in the areas of kindness and compassion.<sup>2</sup> Thomas et al. also surveyed hospital patients and found that the nurse with the most body art was rated less caring, skilled, knowledgeable and professional.<sup>1</sup> In comparison to ratings made by patients and faculty, student nurses rated the nurse with the most body art to be more caring than a nurse without tattoos, suggesting that younger health care workers did not view body art negatively.<sup>1</sup>

Two studies conducted in dentistry evaluated perceptions of visibly tattooed dental hygienists in regards to professionalism.<sup>17,21</sup> Quiros et al. found

visibly tattooed dental hygienists, despite the size (small or large) of tattoo, were perceived negatively by dentists when compared to dental hygienists without visible tattoos.<sup>21</sup> Quiros concluded dentists surveyed in the Commonwealth of Virginia were most concerned with their practice image in terms of patient perceptions and acceptance.<sup>21</sup> The presence of visible tattoos may impact how female dental hygienists are perceived by dentist employers and consequently hinder employment opportunities. Verrisimo et al. studied dental patients' perceptions of dental hygienists with visible tattoos of varying sizes in regards to perceived professionalism and found that hygienists with large visible tattoos were perceived as being less professional, than the dental hygienist with no or small tattoos.<sup>17</sup>

Among the millennial generation, a survey by Foltz showed that 86% of college students believed any student with visible tattoos would have a harder time finding employment and 95% of those surveyed stated that they would make sure tattoos were not visible during a business interview.<sup>12</sup> However, other research indicates that these negative stereotypes may be changing, especially in the younger generation.<sup>22-23</sup> Swami et. al. concluded from two separate studies that traditional differences in perceptions regarding body art will fade as visible tattoos become more mainstream, and that tattooed and non-tattooed individuals have more commonality than differences.<sup>22-23</sup>

Evidence-based research should be included in dress code policies to the same extent that other policies and practices in health care are applied.<sup>1,10</sup> Dress code policies regarding the visibility or concealment of tattoos in health care and educational environments, lack supporting evidence.<sup>24</sup> Dorwart et al. reported findings from a telephone survey regarding body art policies for nursing employees. Of the 13 hospitals that shared their policy on body art, none of the institutions provided a rationale or scientific research supporting their existing protocol.<sup>10</sup> Resenhoft et al. conducted two experimental studies with community college students and found that tattoos negatively influenced the students' perceptions of an individual in 13 different personal areas. An implication of the study findings is that a health care provider may potentially have more negative perceptions towards patients with tattoos when compared to one without tattoos. Further study is indicated in regards to health care providers' perception of individuals with tattoos and the impact on patient care outcomes.<sup>25</sup> Understanding the effects tattoos have on the health care professions as well as public perceptions will build the evidence based model necessary for providing the best quality of care.

There is a gap in the literature on the dress code policies and regulations regarding visible tattoos in oral health care education, including dental hygiene.

While the image of what constitutes dental hygiene professionalism originates in education, there is no research on the role dental hygiene administrators' perceptions plays concerning students with visible tattoos or how existing policies on visible tattoos are established and enforced in dental hygiene education. The purpose of this study was to survey the perceptions of dental hygiene program directors toward dental hygiene students with visible tattoos and to determine current policies related to dress codes in United States (U.S.) dental hygiene programs.

## Methods

A fourteen-item investigator-designed electronic survey was administered via a commercial web based software company (www.surveymonkey.com) and distributed to the 340 U.S. dental hygiene program directors of entry level dental hygiene programs, as reported by the American Dental Hygienists' Association.<sup>26</sup> The study was determined to be exempt by the Old Dominion University College of Health Sciences Institutional Review Board Committee and all responses were collected anonymously. One follow-up email was sent two weeks after the initial survey was distributed and the survey was available for three weeks.

The *Dental Hygiene Tattoo Survey* introduction letter provided the participants information about the study, and obtained participant consent. The survey consisted of four demographic questions related to gender, age, and program demographics; two open ended questions related to policies and personal tattoo status; and ten questions where participants used a seven point Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree), to indicate their impressions of visible tattoos in dental hygiene education on the basis of professionalism, concern, impact, and appropriateness. A panel of Old Dominion University marketing and dental hygiene faculty reviewed the questionnaire to establish content validity and to test clarity of instructions. Modifications to the survey instrument were made based on the panel's review of the survey. Two open-ended questions were transcribed and qualitatively analyzed by coding responses according to distinct ideas. All coding was reviewed by a colleague prior to frequency analysis to establish content reliability. Differences in response frequency issues were discussed, and calibration in responses was achieved.

## Data analyses

Statistical analyses were performed using SPSS 21 software and the significance level was set at  $p < 0.05$ . Descriptive statistics were used to analyze response frequency to open and closed ended questions. Statistically significant differences for Likert type scale questions were determined using a one-sample t-test and compared to a neutral rating of 4.0. Open-ended questions were transcribed and

qualitatively analyzed by coding responses according to distinct ideas. A linear regression model was used to determine the relationship between the respondent's age and satisfaction with current program policies related to visible tattoos. In addition, respondents' tolerance toward tattoos in general in relation to their satisfaction with current policies was also determined. A binomial logistic regression model was used to determine the effects of respondent's age and tolerance of tattoos with the presence of a policy on visible tattoos.

## Results

Of the 340 U.S. dental hygiene program directors invited to participate, nine emails were undeliverable for a total of 331 invitations. A total of 141 (n=141) program directors successfully completed the survey for a response rate of 43%. Five participants did not complete the entire survey; therefore, were not included in the response rate. The majority of participants were female (95%) and 77% were employed in an educational institution that awarded an associate degree (Table I). Participants ranged in age from twenty-nine to seventy years, with an average age of 54.86 years (SD=7.76). Most participants (73%) were between the ages of fifty and sixty-four, and 7% were aged sixty-five and older. Respondents were representative of all regions in the U.S., with the largest percentage from the South (Table II).

The majority (80%) of respondents reported their

**Table I.** Demographic Data by Number and Percentage of Total Respondents (n=145)

	Number	Percentage
<b>Gender</b>		
Female	139	95%
Male	7	5%
<b>Age (years)</b>		
Under 35	3	2%
36-45	16	11%
46-55	45	31%
56-65	77	53%
Over 66	4	3%
<b>Awarded credential (entry-level program)</b>		
Certificate	2	1%
Associate's degree	113	77%
Bachelor's degree	42	29%

respective dental hygiene program had a dress code policy on visible tattoos. Respondents indicating that their program had policy regarding visible tattoos (n=113), 14% reported their policy applied exclusively to students while 89% reported that their



**Table II.** Program Location by Region, Number and Percentage of Total Respondents (n=145)

Region	Number	Percentage
Northeast (Connecticut, Minnesota, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, Pennsylvania)	28	19%
Midwest (Indiana, Illinois, Michigan, Ohio, Wisconsin, Iowa, Kansas, Missouri, Nebraska, North Dakota, South Dakota)	30	21%
South (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas)	51	35%
West (Arizona, Colorado, Idaho, New Mexico, Minnesota, Utah, Nevada, Wyoming, Alaska, California, Hawaii, Oregon, Washington)	36	25%

policy applied to both faculty and students. Twenty percent (n=28) of the respondents did not currently have a dress code policy on visible tattoos, with 43% indicating a need for written tattoo policy while 57% of those without a policy indicated that a written tattoo policy was unnecessary. When participants were asked about personal tattoo status, the vast majority of the respondents (87%) reported they did not personally have a tattoo. Of the eighteen program directors indicating having a tattoo, only one reported that the tattoo was visible. The majority of the respondents with tattoos (83%), reported having fewer than three tattoos.

A seven-point Likert type scale ranging from strongly disagree (1) to strongly agree (7), was used to indicate participants' opinions of visible tattoos on the basis of professionalism, concern within the school, dress code policy satisfaction, tolerance toward visible tattoos, whether visible tattoos needed to be covered, impact on future employment, and impact on community opinions (Table III). A one-sample t-test was used to determine statistically significant differences compared to a neutral rating, defined as a score of 4.0 (Table IV). Results reveal both students (Mean=5.57, SD=1.44,  $p<.0005$ ) and faculty (Mean=5.76, SD=1.49,  $p<.0005$ ) with visible tattoos are perceived as significantly less professional by respondents (Mean $\Delta$ =-1.57, 95% CI [-1.82 to -1.33],  $t(138)=12.82$ ); (Mean $\Delta$ =-1.76, 95% CI [-2.01 to -1.51],  $t(138) = 13.93$ ). Additionally, significantly more respondents agreed than disagreed that visible tattoos on students (Mean=4.73, SD=1.99,  $p<.0005$ ) are a concern in their dental hygiene programs (Mean $\Delta$ =-.0.73, 95% CI [-1.05 to -0.41],  $t(138) = 4.50$ ). However, visible tattoos on faculty (Mean=3.13, SD=2.22,  $p<.0005$ ) typically were not perceived as a problem since most respondents disagreed with this statement (Mean $\Delta$ =0.88, 95% CI [0.51 to 1.26],  $t(138)=-4.69$ ).

Significant differences were also found when evaluating participants' level of satisfaction (Mean=5.77, SD=1.56) with their program's existing dress code policy concerning visible tattoos (Mean $\Delta$ =-1.77, 95% CI [-2.03 to -1.51],  $t(138) = 13.40$ ,  $p<0.0005$ ). Results suggest that most program directors are satisfied with their existing visible tattoo policies. In regards to tolerance toward visible tattoos, results suggest most respondents believe visible tattoos should be covered in the educational setting (Mean=3.23, SD=2.22) (Mean $\Delta$ =0.73, 95% CI [0.38 to 1.09],  $t(138) = -4.09$ ,  $p<0.0005$ ). Additionally, results reveal significantly more respondents agreed than disagreed that visible tattoos should be covered in both clinical (Mean=5.75, SD=1.79) (Mean $\Delta$ =-1.74, 95% CI [-2.04 to -1.44],  $t(138) = 11.46$ ,  $p<0.0005$ ), and community settings (Mean=4.80, SD=2.11) (Mean $\Delta$ =-0.78, 95% CI [-1.14 to -0.43],  $t(138) = 4.39$ ,  $p<0.0005$ ).

Most participants (Mean=6.20, SD=1.27) agreed that faculty should discuss the impact of visible tattoos on future employment opportunities (Mean $\Delta$ =-2.19, 95% CI [-2.41 to -1.98],  $t(138)=20.32$ ,  $p<0.0005$ ). Mean community impact score (Mean=5.50, SD=1.55) indicated most participants' agreed that the community would view the school as less professional if students had visible tattoos (Mean $\Delta$ =1.50, 95% CI [-1.77 to -1.24],  $t(138) = 11.33$ ,  $p<0.0005$ ). Results also suggest program directors believe people hiring students (Mean=5.45, SD=1.62) would feel that the school is less professional if students had visible tattoos (Mean $\Delta$ =-1.47, 95% CI [-1.75 to -1.20],  $t(138)=10.70$ ,  $p<0.0005$ ). The majority of participants (Mean=2.99, SD=1.78) disagreed with the statement that people in their area are particularly liberal (Mean $\Delta$ =1.01, 95% CI [.72 to 1.31],  $t(138) = -6.73$ ,  $p<0.0005$ ).

Of the 146 respondents, 112 provided responses to the open-ended questions on program policy description and identification of the program policy maker concerning visible tattoos. The majority of these participants (97%) focused their tattoo policy description with regard to the covering of visible tattoos. More detailed responses concerning policy descriptions regarding covering tattoos were further subcategorized and results are found in Table IV. Identification of program policy maker(s) was analyzed according to

**Table III.** Percentage Scores of Respondent's Perceptions of Visible Tattoo Policies (N=141)

	<b>1 Strongly Disagree</b>	<b>2</b>	<b>3</b>	<b>4 Neutral</b>	<b>5</b>	<b>6</b>	<b>7 Strongly Agree</b>	<b>Total</b>
I believe dental hygiene STUDENTS with visible tattoos are perceived as less professional.	0.71% 1	4.26% 6	2.13% 3	16.31% 23	17.73% 25	23.40% 33	35.46% 50	141
I believe visible tattoos on STUDENTS are a concern in our program.	5.67% 8	12.77% 18	7.80% 11	14.89% 21	15.60% 22	20.57% 29	22.70% 32	141
I believe dental hygiene FACULTY with visible tattoos are perceived as less professional.	0.71% 1	5.67% 8	2.13% 3	9.93% 14	13.48% 19	25.53% 36	42.55% 60	141
I believe visible tattoos on FACULTY are a concern in our program.	36.88% 52	15.60% 22	8.51% 12	9.93% 14	5.67% 8	10.64% 15	12.77% 18	141
I am satisfied with my program's existing dress code policy concerning visible tattoos.	1.43% 2	2.86% 4	7.14% 10	10.71% 15	8.57% 12	21.43% 30	47.86% 67	140
I believe tattoos may be visible if discreet/appropriate and NOT offensive.	31.21% 44	16.31% 23	10.64% 15	12.77% 18	6.38% 9	13.48% 19	9.22% 13	141
I believe visible tattoos should be covered while in the clinical setting.	2.84% 4	7.09% 10	4.26% 6	9.22% 13	6.38% 9	14.18% 20	56.03% 79	141
I believe visible tattoos should be covered while in the community setting.	9.22% 13	11.35% 16	7.80% 11	12.77% 18	12.77% 18	11.35% 16	34.75% 49	141
I believe offensive/inappropriate tattoos must be covered at ALL times (clinic, classroom, community).	5.67% 8	4.96% 7	4.26% 6	5.67% 8	1.42% 2	7.80% 11	70.21% 99	141
I believe faculty should discuss the impact of visible tattoos on future employment opportunities.	0.71% 1	2.84% 4	1.42% 2	4.96% 7	9.22% 13	21.99% 31	58.87% 83	141
I believe people in our community would feel our school is less professional if students had visible tattoos.	2.13% 3	4.96% 7	4.26% 6	9.93% 14	19.15% 27	26.95% 38	32.62% 46	141
I believe people hiring our students would feel our school is less professional if students had visible tattoos.	2.13% 3	4.96% 7	6.38% 9	12.06% 17	12.77% 18	26.24% 37	35.46% 50	141
I believe people in this area are particularly liberal.	25.53% 36	22.70% 32	12.77% 18	19.15% 27	7.09% 10	7.80% 11	4.96% 7	141

**Table IV.** One Sample t-test Results Comparison of Mean Values of Program Director Responses to Neutral Rating

	t	df	Sign. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
I believe dental hygiene STUDENTS with visible tattoos are perceived as less professional.	12.815	138	.000	1.57554	1.3324	1.8186
I believe visible tattoos on STUDENTS are a concern in our ...	4.502	138	.000	.72662	.4075	1.0457
I believe dental hygiene FACULTY with visible tattoos are perceived as less professional.	13.929	138	.000	1.76259	1.5124	2.0128
I believe visible tattoos on FACULTY are a concern in our ....	-4.686	138	.000	-.88489	-1.2583	-.5115
I am satisfied with my program's existing dress code policy concerning visible tattoos.	13.399	138	.000	1.76978	1.5086	2.0309
I believe tattoos may be visible if discreet/appropriate and NOT offensive.	-4.091	138	.000	-.73381	-1.0885	-.3791
I believe visible tattoos should be covered while in the clinical setting.	11.461	138	.000	1.74101	1.4406	2.0414
I believe visible tattoos should be covered while in the community setting.	4.392	138	.000	.78417	.4311	1.1372
I believe offensive/inappropriate tattoos must be covered at ALL times (clinic, classroom, community).	12.117	138	.000	1.94864	1.6315	2.2678
I believe faculty should discuss the impact of visible tattoos on future employment opportunities.	20.316	138	.000	2.19424	1.9807	2.4078
I believe people in our community would feel our school is less professional if students had visible tattoos.	11.3228	138	.000	1.49640	1.2352	1.7576
I believe people hiring our students would feel our school is less professional if students had visible tattoos.	10.696	138	.000	1.47482	1.2022	1.7474
I believe people in this area are particularly liberal.	-6.729	138	.000	-1.01439	-1.3125	-.7163

**Table V.** Open Ended Responses Concerning Program Policy Description and Program Policy Maker Identification (n=112)

	Number	Percentage
Program policy description		
Cover in all settings representing the school	34	30%
Cover only in clinical settings	46	41%
Cover by band aid and/or makeup	14	13%
Cover only if considered offensive	2	2%
Cover due to infection control protocol	1	1%
Program policy maker		
Credentialed dental faculty team	85	76%
Curriculum committee including students	3	3%
Corporate education department	4	4%
Dental hygiene program director only	9	13%

the following groups: credentialed dental faculty team (76%), curriculum committee (including students) (3%), corporate education department (4%), and dental hygiene program director exclusively (13%) (Table V).

An ordinary least squares (OLS), linear regression analysis was conducted to determine if participants' age and tolerance towards visible tattoos was statistically associated with participants' satisfaction with the program tattoo policy (Table VI). For this analysis, tolerance ratings were defined by responses to the Likert scale statement, 'I believe tattoos may be visible if discreet/appropriate and not offensive.' Ratings of program tattoo policy satisfaction was defined by responses to, 'I am satisfied with my program's existing dress code policy concerning visible tattoos.' The OLS regression model is significant ( $F(2, 135) = 10.06, R^2 = .13, p < .001$ ). The analysis showed tolerance toward tattoos ( $\beta = -0.36, p < 0.001, 95\% \text{ CI } [-.38, -.15]$ ) not age ( $\beta = -0.06, p = 0.50, 95\% \text{ CI } [-.04, .02]$ ) was significantly associated with satisfaction concerning program tattoo policies. Program directors who indicate a decreased tolerance toward visible tattoos are more likely to be satisfied with their program tattoo policy.

A logistic regression was performed to determine if an association existed between age and tolerance towards tattoos with the likelihood that visible tattoos was addressed in dress code policies (Table VII). Tolerance ratings were defined by the same statement used for standard multiple regression

**Table VI.** Summary of Multiple Regression Analysis for Age and Tolerance Scores\*

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Constant	7.26	.95		7.64	.00
Tolerance	-.27	.06	-.36	-4.48	.00
Age	-.01	.02	-.06	-.68	.50

\*Note: Dependent Variable: "I am satisfied with my program's existing dress code policy concerning visible tattoos."

analysis. The logistic regression model was statistically significant,  $X^2(2) = 40.44, p < .0005$ . The Nagelkerke  $R^2$  was .40 and Cox and Snell  $R^2$  was .25. The analysis showed that tolerance toward tattoos ( $\beta = -0.73, p < 0.001$ ) not age ( $\beta = -0.06, p = 0.09$ ) was significantly associated with the likelihood that visible tattoos was addressed in dress code policies. A lower tolerance (negative attitude) towards visible tattoos was associated with an increased likelihood that a program dress code policy on visible tattoos existed. Program directors who have an increased tolerance for visible tattoos are less likely to institute program tattoo policies. Age was not statistically significant at  $p < 0.05$  level.

## Discussion

Results from this study suggest visible tattoos are a concern in dental hygiene educational settings. Data revealed most respondents believe students and faculty with visible tattoos were perceived as being less professional, which may support this study's findings that the majority of dental hygiene programs require that visible tattoos be covered. In contrast, in a pilot study with dental hygiene students, McCombs et al. found only 48% of the students believed visible tattoos should be covered in clinical settings even though most agreed that tattoos were unprofessional.<sup>27</sup> The younger age of the student respondents as compared to the average age (54.86 years) of the program directors could explain this finding.

Findings from the present study are consistent with nursing research in which professionalism was examined. Thomas et al. concluded that self-expression through the display of tattoos should not

**Table VII.** Logistic Regression Analysis on the Likelihood of Instituting Program's Dress Code Policy on Visible Tattoos\*

Predictor	$\beta$	p
Constant	7.87	.001
Tolerance	-.73	.00
Age	-.06	.09

\*Note: Cox and Snell  $R^2 = .25$ . Nagelkerke  $R^2 = .40$ .

be a part of the nursing professional image and tattoos should not be visible when representing a professional role.<sup>1</sup> Results also are supported by Merrill and Westerfield et al. who found that visible tattoos on nurses were perceived by patients as creating a less professional image.<sup>3,16</sup> Moreover, most participants in this study did not view their communities as being liberal. This impression may be related to the required covering of visible tattoos in both clinic and community settings, as respondents may believe that community patients would view the presence of visible tattoos on students unfavorably. Low opinions could result in fewer patient appointments at the program clinic. The majority of the respondents in this study did not describe their community as being particularly liberal. If more respondents had been from liberal communities, policies on visible tattoos in various settings might have been less restrictive.

Concern for visible tattoos on students compared to faculty differed. While the majority of program tattoo policies applied to both students and faculty, participants indicated that visible tattoos on faculty were not a concern in their program. Difference in age may contribute to this finding. Tattoos are especially prevalent and accepted among younger generations, representing one of the largest growing cohorts of tattoo consumers, compared to the baby boomers.<sup>6</sup> In addition to the age of participants in this study, which averaged 55 years, only one respondent indicated that their tattoo was visible. This could explain why respondents did not view visible tattoos as a faculty concern.

Results suggest most participants agreed that members of their community and individuals hiring their graduates would view the school as less professional if students had visible tattoos. These findings are congruent with nursing research demonstrating that nurses were also rated less professionally by community patients if they had a visible tattoo.<sup>1,3,16</sup> Additionally, Verissimo et al. found that dental patients viewed the dental hygienist with a visible tattoo as being less professional.<sup>18</sup> Most participants agreed that faculty should discuss the impact of visible tattoos on future employment opportunities. Dental hygiene programs want to graduate competent, professional individuals who

are worthy of employment. Timming et al. as well as Quiros et al. reported that body art may significantly impact hireability, lowering employment opportunities when applicants displayed visible body art.<sup>21,28</sup> Moreover, Burgess et al. found that regardless of employers' personal feelings about tattoos, if they believed clients would rate tattoos as unprofessional, the employer would not choose to hire an individual with visible tattoos.<sup>29</sup>

Tattooing may also impact employment opportunities specifically for dental hygienists. Gender bias toward women with tattoos is supported in the literature and has particular relevance for the female dominated profession of dental hygiene.<sup>2,16</sup> Hence, it may be relevant and important for programs to discuss the placement of tattoos with students. A discussion on the effect of visible tattoos on the dental hygiene professional and possible gender bias could be incorporated into the curriculum within an existing practice management course.

Individuals from various geographic regions of the U.S. may differ in how they perceive members of their communities would view dental hygienists with visible tattoos. Furthermore, study respondents who viewed their communities as being liberal, may believe the need for a dress code policy on visible tattoos is not warranted. Tattoos may be accepted and possibly even enhance the image of a health care provider and a dental practice in segments of the population considered to be liberal. Timing et al. noted that some workplace settings may prefer a certain employee aesthetic if catering to clients with tattoos.<sup>28</sup> Therefore, employers may even prefer that their employees have tattoos so they appear more similar to their clients; this could apply to dental practices as well.

Some participants indicated that a written tattoo policy was not necessary for their program. This may relate to a lack of prevalence of students and faculty with visible tattoos and/or the perception that small, appropriate tattoos do not negatively affect professionalism. In communities more tolerant of tattoos, perceptions concerning professionalism of the individual with a visible tattoo may be dependent on size, gender, degree, and type of image. Taking this into consideration, dental hygiene programs may address the occasional student or faculty member with a visible tattoo on an individual basis. Furthermore, younger persons may find tattoos to be attractive with few negative stereotypes.<sup>12,28</sup> Depending on the average age of the patient base in a community, health care hiring managers may find visibly tattooed health care professionals are not offensive, and may even enhance the image of the practice.<sup>28</sup>

While age is considered an important factor affecting attitudes toward tattoos, participants' age in the current study was not significantly associated with participants' satisfaction with program tattoo

policies or with the likelihood that a program dress code policy on visible tattoos existed. This finding was surprising since most (82%) of the participants were over the age of 50. Although the relationship between age and the likelihood that a program dress code policy on visible tattoos existed narrowly missed accepted statistical significance ( $p=0.09$ ), some scholars do report statistical significance when  $p<0.10$ .

Results from this study may help dental hygiene programs make valid, reliable and evidence-based decisions regarding policies related to visible tattoos. Study findings may also help faculty and administrators assist students in understanding hiring practices related to visible tattoos and potential barriers in employment settings. The teaching of professionalism is an important aspect of health care education because appearance may affect a patient's image of the health care professional.<sup>1,16,18</sup> Today's millennial students will be creating program policies and making hiring decisions in the future.<sup>12</sup> Existing program policies regarding visible tattoos may become less restrictive as younger generations assume future administrative positions in dental hygiene education.

Several limitations may have influenced the study findings. Of the 331 dental hygiene program directors emailed, only 141 directors responded and completed the survey in its entirety. The limited response rate (43%) may be due to the timing of the survey distribution (spring break) for some institutions and may limit the generalizability of results to all U.S. dental hygiene programs. Future researchers should consider distributing the survey during a different time of the year, such as the middle of fall semester when the majority of educational programs are in session. The limited age range of the participants may not have been representative of perspectives of younger dental hygiene program directors. Results may also not be generalizable outside the U.S. due to differing cultural perspectives on visible tattoos. Lastly, researcher bias must also be accounted for with a purposive sampling technique. While survey questions inquired about possible relationships between tattoo policies and program directors' attitude toward visible tattoos, explicit questions investigating the rationale behind the tattoo policy or lack thereof, was not defined. Future studies should consider the impact race, religion and patient's perception of dental hygienists and students with visible tattoos, as well as specific types and size of tattoos.

## Conclusion

Perceptions of professionalism in health care are important in promoting positive patient interactions and outcomes that are influenced by clinician appearance. This study highlights dental hygiene program directors' perceptions of students and faculty

with visible tattoos. Policies limiting visible tattoos in educational settings by covering, are prevalent and may be related to perceived negative perceptions that may be occurring within the community at large. Additionally, program directors' personal perceptions may have influenced school dress code policies. These findings provide insightful information for dental hygienists, students, faculty, administrators and hiring managers as they formulate and implement policies relating to body art.

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## Engaging Stakeholders in Patient-Centered Outcomes Research Regarding School-Based Sealant Programs

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### Abstract

**Purpose:** The purpose of this study was to use qualitative methods to describe the key lessons learned during the stakeholder engagement stage of planning a randomized clinical trial comparing outcomes of silver diamine fluoride (SDF) as an alternative to pit-and-fissure sealants in a school-based delivery system.

**Methods:** Eighteen caregivers and community-based stakeholders with involvement in the school-based sealant program Sealants for Smiles from the state of Montana, were recruited for this qualitative study. United States (U.S.) Patient-Centered Outcomes Research Institute (PCORI) methodology standards were used to develop two semi-structured interview guides consisting of 6 questions. One interview guide was used for telephone interviews with caregivers and the second was used for a stakeholder focus group. Content analytic methods were used to analyze the data.

**Results:** All participants believed that a study comparing SDF and sealants was clinically relevant. Non-caregiver stakeholders agreed with the proposed primary outcome of the study (caries prevention) whereas caregivers also emphasized the importance of child-centered outcomes such as minimizing dental anxiety associated with dental care. Stakeholders described potential concerns associated with SDF such as staining and perceptions of safety and discussed ways to address these concerns through community engagement, appropriate framing of the study, proper consent procedures, and ongoing safety monitoring during the trial. Finally, stakeholders suggested dissemination strategies such as direct communication of findings through professional organizations and encouraging insurance plans to incentivize SDF use by reimbursing dental providers.

**Conclusions:** Involving key stakeholders in early planning is essential in developing patient-centered research questions, outcomes measures, study protocols, and dissemination plans for oral health research involving a school-based delivery system.

**Keywords:** silver diamine fluoride, pit-and-fissure sealants, caries prevention, school-based sealant programs

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### Introduction

Many of the children in the United States (U.S.) at risk for developing dental caries encounter barriers to receiving preventive dental care.<sup>1,2</sup> School-based oral health programs play an important role in reducing barriers to care for socioeconomically vulnerable children.<sup>3,4</sup> Consistent with Healthy People 2020 objectives,<sup>5</sup> school-based programs focus on resin pit-and-fissure sealants, to prevent dental disease in children. However, successful placement of resin sealants is technique sensitive and most often requires four-handed application in order to maximize sealant retention.<sup>6</sup>

Topical silver diamine fluoride (SDF) is a safe and effective chemotherapeutic medicament that has been shown to arrest active carious lesions.<sup>7</sup> SDF has

been used by dental providers in countries outside the U.S. for decades. However, SDF was not commercially available in the U.S. until it was cleared by the U.S. Food and Drug Administration in mid-2014 as a tooth desensitizer. SDF (Advantage Silver Arrest™, Elevate Oral Care, LLC, West Palm Beach, FL) is currently available for off label use by dental providers. *In vitro* studies suggest SDF has an antimicrobial effect and, in addition, the silver mechanically blocks dentinal tubules.<sup>8,9</sup> A recent study also indicates that SDF specifically interacts with calcium and phosphate ions to produce fluorohydroxyapatite.<sup>10</sup>

While SDF is traditionally used to arrest existing caries, its ability to also block fissures broadens the possibility of its clinical utility as a sealant material. SDF is an appealing alternative to resin sealants



in school-based programs because it requires less clinical time to apply than resin sealants, is inexpensive, is less technique sensitive, and can be applied by a single dental provider without expensive portable equipment.<sup>11</sup> Three randomized clinical trials comparing SDF and sealants as caries prevention strategies have demonstrated mixed results.<sup>12-14</sup> The first of these trials found no effect on dentinal caries prevention associated with SDF placed on the first permanent molars of six- to eight-year old children when compared to no treatment as a control.<sup>12</sup> The second study demonstrated that SDF was equally as effective at caries prevention as a fluoride-releasing glass ionomer in the primary molars of four to six-year old children.<sup>13</sup> However, both studies allowed carious teeth to be included, which indicates that the outcomes included primary and secondary prevention, rather than focusing on primary prevention. The third clinical study showed that SDF was equally as effective as toothbrushing and glass ionomer sealants in preventing initial occlusal caries in newly erupting permanent first molars.<sup>14</sup> As with the previously mentioned trials, important patient-centered outcomes, such as ease of treatment or dental anxiety reduction, were not assessed.

The goal of patient-centered outcomes research (PCOR) is to improve health outcomes and care quality by including patients and stakeholders in the entire research process, beginning with the research question formulation and extending to the dissemination of the findings.<sup>15</sup> While there are many examples of the stakeholder engagement process from medicine,<sup>16,17</sup> there are no PCOR examples from dentistry or dental hygiene reported in the literature. True community-based, participatory research is relatively uncommon in oral health researcher<sup>18</sup> and randomized trials of dental pharmaceuticals based on PCOR methods have not been reported.

Patient centered outcomes in school based sealant programs have not been assessed. The purpose of this study was to use qualitative methods to describe lessons learned during the stakeholder engagement stage of planning a randomized clinical trial comparing outcomes of silver diamine fluoride (SDF) as an alternative to pit-and-fissure sealants in a school-based delivery system with the goal of identifying the key points learned by involving caregivers and stakeholders in the research process. These findings have implications for developing appropriate patient-centered research questions, identifying relevant outcomes, designing acceptable study protocols, and conceptualizing an effective dissemination strategy.

## Methods

### Participant Recruitment

Caregivers of children who had participated in Montana's *Sealants for Smiles* Program, a school-based sealant program focusing on low-income children without access to preventive care, were recruited for

this study. Community-based stakeholders throughout Montana involved in public health, dental care delivery systems, schools, local and state health organizations, and dental insurance plans were also recruited for the study. Caregivers were invited to participate in one-on-one interviews while stakeholders were recruited for a focus group session. Caregiver interviews and the stakeholder focus group were conducted separately because of scheduling conflicts with participants.

### Interview Scripts

Two semi-structured interview scripts, one for caregiver interviews and for the stakeholder focus group, were developed (Table I). The U.S. Patient-Centered Outcomes Research Institute (PCORI) Methodology Standards<sup>19</sup> were used to develop questions divided into four domains corresponding to stages in the research process: 1) formulating a patient-centered research question; 2) pre-intervention procedures; 3) intervention procedures; and 4) post-intervention procedures. The interview scripts were pre-tested with representative caregivers and stakeholders, revised to improve flow, and finalized.

### Data Collection and Analyses

Caregiver interviews were conducted by telephone and the stakeholder focus group was held in person during summer 2016. All conversations were digitally recorded, transcribed by a professional transcription service, verified for accuracy, and de-identified prior to analysis. Data were analyzed using inductive content analytic methods and findings were organized into the four outlined previously.<sup>20</sup> The study was determined to be exempt by the University of Washington Institutional Review Board.

## Results

### Participants

Two caregivers were recruited for one-on-one telephone interviews. There were 16 focus group participants, including 5 members of professional health organizations, 3 school nurses, 3 school principals and Parent Teacher Association (PTA) leaders, and 5 representatives of other stakeholder groups (e.g., pediatric medicine, federal health agency, community health center, insurance company, industry). Many of the focus groups participants were also parents or caregivers, enabling them to provide professional as well as parent perspectives.

### Formulating a Patient-Centered Outcomes Research Question

#### *Significance of Topic*

There was consensus among caregivers and stakeholders about the importance of oral health. A pediatric dentist explained why preventive care is particularly important for children because "we see kids come in weekly with [bombed] out molars by age

**Table I.** Semi-Structured Questions for Caregiver Interviews and Stakeholder Focus Groups

**Caregiver Interview Questions**

1. What are some of the benefits you can think of that come from checkups?
2. How important is it to prevent cavities?
3. Has your child (or a child you know) ever gotten sealants?
4. What kinds of difficulties have you seen your child (or children in general) experience when getting sealants?
5. Has your child ever talked to you about being nervous or hesitant about going to the dentist again, after getting sealants?
6. How important are the (described) benefits of silver diamine fluoride?
7. How supportive would you be of a study that compares sealants and silver diamine fluoride, in terms of reducing the amount of anxiety or nervousness reported by your child?

**Stakeholder Focus Groups Questions**

1. What are your feelings about the preferred design for the trial?
2. Do you have suggestions for improving the study design?
3. What role do you feel you might have in finalizing the districts or schools to be involved in the trial?
4. What role do you as a stakeholder feel you might have in how the trial is presented to schools and parents?
5. Do you see your organization actively participating in the publicity around the trial or even interacting with school districts or parents?
6. What role do you feel you might have in monitoring the progress of the trial?
7. What role do you feel you might have in helping interpret the results of the trial?
8. What role do you feel you might have in disseminating the results of the trial?

ten and it's really detrimental to their health." One mother shared that she "didn't have sealants [as a child] and I'm still battling with cavities. Both my two daughters have had sealants and don't have cavities".

A pediatric dentist described having found "a really great use [for silver diamine fluoride] in my practice" to manage tooth decay in "patients that we've done general anesthesia on that we know are going to have a tough time [providing treatment on new tooth decay] or be medically challenging to put them under general anesthesia again; for non-cavitated white spot lesions; for patients who are awake and... have a horrible gag reflex and we physically cannot get back there to isolate [the molars for sealants]." But the pediatric dentist remained cautiously optimistic. "I mean we'll see what the research says and everything but I really feel like it's a very safe thing to do and I think that it probably provides a lot more benefit than even traditional sealants but it is something that's new and going to rock the boat of a lot of dentists".

**Outcomes**

Non-caregiver stakeholders did not question the proposed outcome of the study (caries prevention). Caregivers, on the other hand, spoke more broadly about the importance of child-centered outcomes like making preventive dental treatment easier and minimizing child dental anxiety. As one mother explained, "If my daughters do well [with silver diamine fluoride] and it is quicker and just as effective, it would be better [than sealants]". She went on to explain that while preventing cavities is important, minimizing anxiety would be "better because they will take care of their teeth as adults. I still get anxious [when going to the dentist] even when I know it won't hurt". Another mother said that "as a mom, I'm all for easier. My kids have had silver diamine fluoride. Sealants fall out. I'd be all for shorter appointments and where I don't have to coax my child. I am definitely...supportive of this study".

**Vulnerable Population Subgroups**

Several participants stressed the importance of including high-risk children, including American Indian children and children with special health care needs (CSHCN). A community dentist asked "is there an intent...to include the [American] Indian population? I [would] really like to see the outcomes of this with our high-risk kids." Another dentist believed that it "would be great to have a vulnerable population and, you know, include [CSHCN] in the study and I think it would be needed... those [children] are the ones that I think would benefit the greatest." A pediatrician agreed, stating that CSHCN "is probably the best population for this...study" but expressed concern about potential factors that can interfere with the effectiveness of preventive care like medication use or dry mouth, which are common among CSHCN.

## **Pre-Intervention Procedures**

### ***Concerns about Silver Diamine Fluoride***

A PTA leader asked about potential “side effects of what’s being currently used [sealants] versus...the new treatment [silver diamine fluoride]” including “toxicity potential”. A pediatrician asked how long SDF has been used in countries outside of the U.S. and believed that “if you talk about silver [in Montana], I think there would be a large number of people that just kind of stop listening”. There were concerns expressed by a dentist who uses SDF in clinical practice about the importance of using SDF carefully to avoid unintentional staining, especially on anterior teeth with incipient carious lesions and the soft tissues.

### ***Community Engagement***

To address concerns about SDF, stakeholders emphasized the importance of engaging with members of the communities in which the study will take place, including local dentists, pediatricians, schools, public health officials, and community members. One dentist believed “there would have to be some sort of educational piece with the dentists of the community” especially because caregivers are likely to approach trusted local dentists for a second opinion about SDF. A pediatrician saw the role of pediatricians as complementing the role of dentists by being “a partner in educating. And, I don’t know that we would convince everybody but it’s possible that that could be very helpful.” Multiple stakeholders stressed the importance of “buy-in from all the school programs, the school districts from the principals down to the individual teachers” and warned that “getting everybody on-board and making those contacts at the schools is very time-consuming and...something that definitely needs to be taken into consideration”.

## **Intervention Procedures**

### ***School Recruitment***

Stakeholders proposed strategies to identify and access local schools for the proposed study. A dentist mentioned that recruitment should focus on “individual schools with progressive and flexible leadership...[that] are really easy to work with”. Numerous stakeholders said that a school-based approach is more effective than approaching school districts because districts are more difficult to navigate. A PTA leader emphasized the need to figure “out what schools and what administrations are most flexible... and [which] teaching staff is supportive and flexible”. Participants believed that existing community-based relations could be leveraged by partnering with local health departments, community dentists, school nurses, and school wellness advisory committees.

## **Framing the Study**

Stakeholders emphasized the importance of framing of the study to ensure that caregivers, schools, and community members understand and support the study. One dentist mentioned that concerns are raised when terms like “demonstration project” or “pilot study” are used. Similarly, a school nurse explained that “if it’s looked at like your child is going to be in a research study and like a lab rat, you know, like “We’re going to do a little experiment on your child,” then it would not...go over very well.” The nurse suggested describing the study as a process to determine “whether one works better than the other and giving a little bit of information [on] why we want to know, because you know, if it costs less... can we use this as effectively” and reach more children in need. A PTA leader believed in the importance of emphasizing safety and describing the public health implications, especially for a new treatment like silver diamine fluoride.

### ***Managing Caregiver Hesitation***

Stakeholders mentioned three potential sources of caregiver hesitation. The first is a concern about safety, especially with the silver component of SDF. A pediatrician reinforced the importance of educating caregivers on “the length of time that [SDF] has been in use and the safety of it and...the long-term studies that show that these kids are truly safe and that they don’t end up with autism or whatever people are going to think [SDF] will cause”. The second is any cost associated with treatment provided in the study, which would be covered by the program. The third is general hesitancy related to uncertainty about health care decisions and lack of perceived need for preventive treatment.

### ***Consenting Caregivers***

A pediatrician stressed the importance of communicating with parents that there are minimal risks associated with study participation. One pediatric dentist who uses SDF in practice explained that “we try to consent really heavily with our parents. If the children are not cooperative and they move and it gets in their saliva and then it ends up staining like a front white or front...tooth where there’s non-cavitated caries...I guess that would just be one consideration... with how you consent parents [so] you know their comfort with the stain involved. With the posterior teeth, we haven’t had pushback in parents. They’re totally fine.”

### ***Safety Monitoring***

Participants described two types of safety monitoring that should take place to detect and manage any adverse outcomes. The first is individual monitoring in which a “school nurse in the district... that would be a contact person.” A pediatrician stated that it would be helpful for local health providers to know about who is participating so that “if something

kind of wonky comes up, then I can know who to contact...to just be part of the team from that standpoint". A community nurse also mentioned community-based monitoring "by having like at least having an annual meeting...of the stakeholders to discuss what's happening."

## Post-Intervention Procedures

### Dissemination

Stakeholders associated with professional clinical organizations mentioned numerous outlets for disseminating study findings. Dentists and a dental hygienist mentioned presentations at the state and local dental societies as ways to communicate findings. One dentist mentioned the importance of also having information on potential reimbursement for preventive procedures. A representative of a dental insurance company stated that "if you can get this type of...treatment into use, I think it could be a game changer [but] getting providers to change their behavior...and to try new things, we obviously have to compensate or incentivize this kind of...innovation". Nurses also mentioned the annual meeting of the state nursing association as well as grassroots dissemination activities involving providers in local communities. Pediatricians, PTA members, and state health officials also mentioned meetings and biweekly or monthly newsletters that are sent to members electronically.

## Discussion

Caregivers and stakeholders were invited to share their thoughts about a proposed patient-centered study to compare outcomes associated with silver diamine fluoride and resin sealants in school-aged children. Three main findings were identified from the interviews and the focus group. First, there were important differences in how researchers and caregivers prioritized outcomes. The initial study design included caries prevention as the primary outcome, which is consistent with clinical trials in dentistry.<sup>12,13</sup> While tooth decay prevention was important, the caregiver interviews revealed that minimizing dental anxiety and ensuring that their children had positive dental experiences were higher priority issues. The patient-centered approach helped identify an outcome measure that is most important to caregivers and their children, which would not have occurred in the typical research study design approach. Focusing on outcomes that are most salient to patients has important implications in how the study is accepted by community members and potential participants and how study findings can eventually be used to improve health outcomes and care quality.

Another finding is the importance of including trusted early adopters from the community as part of the research process, especially when the study involves a new technology like SDF. A growing

number of dental schools and pediatric dentistry residency programs include education on SDF, but dental providers in practice are slowly beginning to use SDF.<sup>21,22</sup> A potential explanation to slow adoption of new technologies is the well-documented barriers to innovation diffusion.<sup>23</sup> The focus group included a clinically active pediatric dentist who is currently using SDF. This was not intentional, but the manner in which this dentist, a trusted member of the community, described clinical successes of using SDF, helped stakeholders who were less familiar with SDF to better understand its properties. Previous research has underscored the importance of involving early adopters to help introduce innovations into clinical settings.<sup>24</sup> Furthermore, the pediatric dentist described important aspects of consent, such as a careful communication to caregivers about the potential risks of SDF such as unintentional staining.

Silver diamine fluoride is a topical medicament in which milligram amounts are applied to the teeth. One drop (5 mg) can seal as many as five teeth. The gingiva is protected with proper cotton gauze isolation, and rinsing of the affected teeth and high volume evacuation is recommended after treatment.<sup>11</sup> However, minute amounts may also be swallowed and absorbed through the gastrointestinal tract or excreted. Minimal amounts may be absorbed through the oral mucosa.<sup>25</sup> Allergies are known but are infrequent outside of chronic occupational exposure. Nevertheless, controversies over the safety of amalgam fillings and fluoride<sup>26,27</sup> reinforce the importance of careful introduction.

Lastly, the process of engaging a diverse group of stakeholders at an early stage of the research helped in developing a comprehensive stakeholder engagement plan for the study.<sup>28</sup> One goal as a result of this process is to recruit a broader group of caregivers of children from vulnerable population subgroups, including American Indian children and children with special health care needs, as well as general members of the community. In addition, this study model has been strengthened based on feedback from stakeholders on the characteristics of children that may potentially modify the effectiveness of silver diamine fluoride and resin sealants, such as dry mouth and medication use. Data collection tools for the implementation of the trial will reflect the improved study model. Finally, stakeholders play an important role in developing and deploying an information dissemination strategy throughout the study period. For instance, working with dental insurance companies to reimburse dentists who use SDF, if it is found to be effective, will be part of the ongoing discussions.

The small sample size, typical of qualitative research was a limitation of the study; and it is not certain that saturation was reached. In addition, it was not possible to include representatives from

all potential vulnerable population subgroups that might be the recipients of the proposed intervention. One missing caregiver component included having parents who might express concerns about staining associated with SDF, which a recent study noted particularly in regards to anterior teeth.<sup>29</sup> Another related study limitation was the potential for bias within the stakeholder focus group process with regards to the dentist participant, who was an early adopter of silver diamine fluoride. However, this dentist did mention concerns parents have about staining, and this issue will be an important part of the pre-intervention procedures and consenting process of the proposed clinical research study.

Important gaps in the initial research and stakeholder engagement plans were identified through the caregiver and stakeholder interviews that will be addressed in the development of the research grant proposal. The absence of patient-centered outcomes research and community-based participatory research methods in dental therapeutic trials may likely limit the acceptance, dissemination, and implementation of scientific advances in school-based oral health. Involving relevant stakeholders in the patient-centered outcomes research process at an early stage can help investigators develop more relevant research questions, outcomes measures, study protocols, and dissemination plans.<sup>30</sup> The expected result is stronger research with greater likelihood that study findings will improve care quality and health outcomes for patients.

## Conclusions

Based on the results of this study, it can be concluded that stakeholders believed in the importance of a study comparing SDF and resin sealants as caries prevention strategies.

However, while caries prevention was an important factor, patient-centered outcomes, such as minimizing a child's anxiety during preventive procedures, were equally as important to caregivers. Finally, pediatric patient-centered outcomes research should include community-based stakeholders and caregivers at the very initial stages of research planning and continue to engage these important individuals throughout the research process.

## Disclosure

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# RESEARCH

## Dental Fluorosis over Time: A comparison of National Health and Nutrition Examination Survey data from 2001-2002 and 2011-2012

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### Abstract

**Purpose:** Excessive fluoride ingestion has been associated with dental fluorosis. The purpose of this study was to determine if there was a difference in dental fluorosis prevalence comparing National Health and Nutrition Examination Survey (NHANES) trend data for adolescents, aged 16 and 17 years, when compared to data collected in 2001-2002 to data from 2011-2012.

**Methods:** The sample included 875 participants. Data analyses included Chi square tests and logistic regressions. The data were from a nationally representative survey by calibrated dental examiners using the modified Dean's fluorosis classification system. The data analysis of the prevalence of fluorosis severity level was dichotomized to very mild/above vs. normal/questionable.

**Results:** In 2001-2002, the weighted percentage prevalence of the denoted dental fluorosis categories were: 49.8% normal (i.e., unaffected), 20.5% questionable, and 29.7% very mild and above. In 2011-2012, the weighted percentage prevalence categories were: 31.2% normal, 7.5% questionable, and 61.3% very mild and above. When comparing years 2001-2002 with the years 2011-2012, the prevalence of very mild and above fluorosis increased by 31.6% ( $P < .0001$ ) for the 2011-2012 group. In adjusted logistic regression, participants from the years 2011-2012 were more likely to have very mild and above dental fluorosis than participants in 2001-2002 as compared with normal/questionable fluorosis (Adjusted odds ratio= 3.85; 95% confidence interval= 2.20, 6.72;  $P < .0001$ ).

**Conclusion:** There was a difference of 31.6% in dental fluorosis prevalence between 2012-2011 when compared to data from 2002-2001 in adolescents aged 16 and 17 years. The continued increase in fluorosis rates in the U.S. indicates that additional measures need to be implemented to reduce its prevalence.

**Keywords:** fluoride, fluorosis, public health, adolescent oral health, tooth development

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### Introduction

Dental fluorosis is defined as the hypomineralization of tooth enamel resulting from chronic, excessive ingestion of fluoride during tooth development, particularly during the pre-eruptive enamel maturation period.<sup>1-4</sup> Dental fluorosis of primary teeth is uncommon as primary tooth development primarily occurs *in utero*; however, if dental fluorosis does occur in primary teeth, it is most commonly observed in the gingival third of the second primary molars.<sup>5</sup> The development of the anterior permanent teeth, in general, begins at approximately ages 15 to 30 months. Therefore, this is a critical time to avoid excess fluoride exposure for the aesthetic appearance of the anterior teeth.<sup>5</sup>

The degree of dental fluorosis severity is fluoride dose dependent. Mild dental fluorosis generally appears as barely visible opacities at the incisal or cuspal edges of teeth; it can also appear as white striations or lacy markings following the enamel perikymata.<sup>1,6</sup> Severe dental fluorosis can have a heavily stained, pitted, friable enamel appearance.<sup>1,6</sup> Generally, the opacities associated with fluoride exposure are symmetrical on contralateral teeth, although post-eruptive staining and attrition of friable enamel associated with severe fluorosis can result in dissimilar appearances of contralateral teeth.<sup>7</sup> In an analysis of national data from 1986-1987 and 1999-2002, there was a nearly 10% increase in dental fluorosis prevalence in participants, aged 6 to 10 years, from 22.8% to 32.2%.<sup>4</sup>

Increasing amounts of available information regarding factors contributing to dental fluorosis and changes in personal behaviors, has led to periodic revisions of the recommendations for fluoride supplementation.<sup>8,9</sup> The American Dental Association lowered the fluoride supplement schedule in 1994 and the American Academy of Pediatrics endorsed the change shortly thereafter.<sup>10,11</sup> The purpose of this study was to determine if there was a difference in the prevalence of dental fluorosis by comparing National Health and Nutrition Examination Survey (NHANES) data for the years 2001-2002 and 2011-2012 in adolescents, aged 16 and 17 years, as a result of the reductions recommended in 1994. There were several reasons for choosing adolescents aged 16 and 17 years for this research. First, the impact of the 1994 fluoride supplement recommendation change had the potential to be discovered in adolescents aged 16 and 17 years in the 2011-2012 data set (i.e., children born in 1994-1996) when compared to adolescents aged 16 and 17 years in the 2001-2002 data set (i.e., children born in 1984-1986 before the 1994 recommendations on fluoride reductions). Second, full mouth, rather than partial mouth, fluorosis evaluation was more likely when evaluating children ages 16 and 17 years than in younger children who were more likely to be in mixed dentition with unerupted permanent teeth, partially erupted permanent teeth, and permanent teeth with surfaces obscured by orthodontic brackets or bands. Finally, although NHANES data included fluorosis information for the years 1999-2004, the contiguous years for 2011-2012 (NHANES data sets 2009-2010 and 2013-2014) did not include fluorosis information.

## Methods

The West Virginia University Institutional Review Board acknowledged this study as non-human subject research (protocol number 1605104903). A cross-sectional study design was used to determine the difference in fluorosis for adolescents identified in 2001-2002 as compared to adolescents identified with fluorosis in 2011-2012.

### Data Source

The data sources for this study were the NHANES 2001-2002 and NHANES 2011-2012. The NHANES is a survey conducted by the National Center for Health Statistics to survey the health and nutritional status of non-institutionalized U.S. residents through interviews and physical examinations.<sup>7</sup> The NHANES dataset is a nationally representative, publically available survey with a complex and multistage sampling design. NHANES interviews were conducted in participants' homes and include sociodemographic, dietary, and health-related information. The health examinations contain medical, dental, laboratory and physiological measurements as well as laboratory tests. Examinations were conducted in specially-designed mobile centers and administered by trained

medical or dental personnel. Each year approximately 5,000 participants are enrolled.<sup>7</sup> NHANES researchers use many of the same questions and test annually; however, changes do occur and questions or procedures can be discontinued, modified, or added in certain years. Researchers use a complex survey design with each participant representing a people similar socioeconomic characteristics. Incorporating the weights and other aspects of the study design in the calculations improves the accuracy of results. Details of the NHANES research procedures are available on the NHANES website.<sup>7</sup>

Licensed dentists with a DDS or DMD degree served as the examiners for the dental fluorosis evaluations in the NHANES studies.<sup>7</sup> Data quality assurance was achieved through initial education and calibration of the examiners and periodic monitoring, recalibration and review.<sup>7</sup> The reference examiner observed and repeated 20-25 examinations when he or she visited the examiners.<sup>7</sup> There were 1-3 site visits conducted per year to maintain reliability and acceptable inter-rater levels.

Dental fluorosis was determined clinically by NHANES dental examiners using a mirror and a modified Dean's fluorosis classification system on permanent (not primary) teeth in participants who were 6-19 years of age using the same technique employed in 2011-12 as well as in 1999-2004.<sup>7</sup> Six categories were used for tooth assessment: normal (translucent, smooth, glossy, pale creamy white); questionable (slight aberrations, a few white spots); very mild fluorosis (less than 25% of tooth has small, white areas); mild fluorosis (between 25% and 50% of the tooth has white areas); moderate fluorosis (50% or more of the tooth with all surfaces involved, with or without brown stains); and, severe fluorosis (all enamel is involved and has discrete or confluent pitting) if its contralateral tooth was also affected.<sup>7</sup> The basis for classifying a person's fluorosis status was the categorization of the two most affected teeth.<sup>7</sup> The lesser affected tooth was to be used to identify the person's status if the two most affected teeth were not equally affected.<sup>7</sup>

In this study, dental fluorosis severity was defined using the definitions provided by the CDC modified Dean's fluorosis classification system. However, due to sample size limitations, severity level was collapsed into: normal, questionable, and very mild/more; and further collapsed into a dichotomized variable of fluorosis status (very mild/more vs. normal/questionable) as was used in previous research on fluorosis.<sup>12-14</sup> The dichotomized variable was used to account for small sample sizes that could not be increased by merging data from contiguous years as fluorosis was not examined in 2009-10 or 2013-14 (years contiguous to 2011-2012) although it was examined in 1999-2000 and 2003-2004 (years contiguous to 2001-2002).



The year of observation (2011-2012 versus 2001-2002) was the main variable. In developing models of logistic regressions, additional variables were selected based upon Krieger's Ecosocial Theory in which embodiment of conditions are the result of biological characteristics, social factors, life course, race/ethnicity, and sex.<sup>15</sup> The model was selected due to the previous associations of fluorosis with 1) having access to fluoride and 2) having enabling resources (higher socioeconomic status).<sup>8,9</sup> The additional variables included in the study were: sex (male, female); race/ethnicity (Non-Hispanic white, Non-Hispanic black, Mexican American, other); medical insurance (yes/no); and federal poverty level (less than 125% of the federal poverty level, 125% to less than 200% of the federal poverty level, 200% to less than 400% of the federal poverty level, and 400% and above). These variables are factors associated with the Ecosocial Theory. Data concerning adolescents, aged 16 and 17 years, were extracted from the available data of children aged 6-19 years for this study.

### Statistical Analysis

Frequency determinations, Rao Scott Chi Square analyses and logistic regression analyses were completed using SAS 9.3® (Cary, NC) software. The complex study design was considered in the analyses. Survey weights provided by NHANES researchers were used to improve the variance estimates. The weights used were adjustments for the representation of a record for the segment of the population represented. Significance was set at an alpha of 0.05.

## Results

### Sample Description

Details of the overall sample are presented in Table I. There were 586 eligible participants in 2001-2002 and 289 eligible participants in 2011-2012 ( $n=875$ ) who had complete NHANES data. Females accounted for 45.7% of the 2001-2002 sample and 54.3% of the 2011-2012 sample (weighted percentages). The analysis excluded 33 participants from the 2001-2002 data sets due to missing data; 14 participants from the 2011-2012 data sets were excluded due to missing information. The race/ethnicity distributions, insurance prevalence, and family income to poverty ratio had no significant differences between 2001-2002 and 2011-2012.

### Ten-year differences in fluorosis

Using the severity of fluorosis as defined by the NHANES modified Dean's classification, in 2001-2002 the prevalence was 49.8% normal, 20.5% questionable, 21.3% very mild, 6.8% mild, 1.6% moderate, and none identified as severe (Table II). In 2011-2012, the prevalence was 31.2% normal, 7.5% questionable, 18.6% very mild, 18.3% mild,

24.3% moderate, and 1.6% severe. Overall, there was a 31.6% increase in fluorosis prevalence ( $P<.0001$ ) when comparing rates from 2011-2012 with those from 2001-2002. Percentages were weighted to improve generalizability.

### Logistic regression on fluorosis

Table III contains the results of logistic regression for the analysis using two categories (very mild and above, and the reference, normal/questionable). The unadjusted odds ratio for the years 2011-2012 versus 2001-2002 was 3.60 (95% confidence interval [CI]: 2.15, 6.05;  $P<.0001$ ). In adjusted analysis with sex, race/ethnicity, federal poverty level and insurance, the odds ratio was 3.85 (95% CI: 2.20, 6.72;  $P<.0001$ ).

Multinomial logistic regression for the analysis using three categories (very mild and above, questionable, and the reference, normal) is also presented in Table III. The 2011-2012 vs 2001-2002 unadjusted odds ratio for questionable fluorosis and the reference, normal, was 0.64 (95% CI: 0.26, 1.57;  $P=0.3149$ ). The adjusted odds ratio was 0.65 (95% CI: 0.27, 1.59;  $P=0.3375$ ).

The 2011-2012 vs 2001-2002 unadjusted odds ratio for mild and above fluorosis and the reference, normal, was 8.25 (95% CI: 4.17, 16.34;  $P<.0001$ ). The adjusted odds ratio was 10.75 (95% CI: 4.79, 24.13;  $P<.0001$ ).

## Discussion

Findings of this study reveal an increase in the prevalence of very mild and above dental fluorosis over the decade, as evidenced by comparing its prevalence in 2001-2002 with that of 2011-2012. There was a lack of national contemporary literature concerning dental fluorosis trends in the U.S. with which to compare this study. However, in a review conducted in 1999, dental fluorosis was clearly increasing in communities with community water system (CWS) fluoride levels below 0.3 parts per million and there were indications of a similar trend with optimal CWS fluoride levels.<sup>16</sup> Researchers of a study conducted in 2003-2004 with North Carolina school children from kindergarten to high school seniors indicated that 71.8% of the children had no fluorosis, 24.4% had questionable to very mild fluorosis, and 3.7% had mild, moderate, or severe fluorosis using the Dean's classification system.<sup>17</sup> The 2001-2002 data for normal/questionable prevalence (70.3%) from the current study supports the findings of the North Carolina study.

In a national survey of children aged 12-15 years, a comparison was made of dental fluorosis prevalence in 1986-1987 and 1999-2004. There was an increase from a prevalence of 22.6% in 1986-1987 to 40.7% in 1999-2004.<sup>18</sup> That study, although evaluating change over a different time period, demonstrated trends in the same direction as the

**Table I.** Sample Description by Row Percentage  
NHANES, 2001-02 and 2011-12

	Number	2001-02 Weighted Number	Weighted %	RES* %	Number	2011-12 Weighted Number	Weighted %	RES* %	P-value
Fluorosis Severity									<.0001
Normal	258	3,806,709	60.7	9.2	87	2,459,906	39.3	14.3	
Questionable	129	1,569,520	72.7	10.1	17	210,206	27.3	28.8	
Very mild	145	1,628,611	52.6	12.3	60	1,468,377	47.4	13.7	
Mild	40	518,699	26.4	16.6	46	1,444,843	74.6	6.0	
Moderate	14	122,515	6.4	42.7	72	1,795,142	73.6	2.9	
Severe	0				8	127,090	100.0		
Fluorosis Severity									<.0001
Normal	258	3,806,709	60.7	9.2	87	2,459,906	39.3	14.3	
Questionable	129	1,569,520	72.7	10.1	17	210,206	27.3	28.8	
Very mild & above	199	2,269,825	31.9	13.2	186	4,835,453	68.1	6.2	
Fluorosis (Dichotomized)									<.0001
Normal/questionable	387	5,376,229	63.8	7.3	104	3,049,593	36.2	12.9	
Very mild and above	199	2,269,825	31.9	13.2	186	4,835,453	68.1	6.2	
Sex									.0744
Female	279	3,621,936	45.7	9.1	148	4,294,973	54.3	7.6	
Male	307	4,024,118	53.7	6.7	141	3,465,876	46.3	7.8	
Race/Ethnicity									.7094
Non-Hispanic - White	171	4,661,473	51.8	10.9	63	8,999,644	48.2	11.8	
Non-Hispanic - Black	174	1,011,293	44.2	14.5	93	1,274,976	55.8	11.5	
Mexican									
American	182	795,074	44.1	12.5	46	1,802,744	55.9	9.8	
Other	59	1,178,215	50.8	11.7	87	1,140,030	49.2	12.1	
Family Federal Poverty Level									.3506
Less than 125% FPL	191	1,948,976	48.4	7.4	104	2,078,354	51.6	6.9	
125% to less than 200% FPL	93	977,734	42.2	7.9	50	1,339,402	57.8	12.4	
200% to less than 400% FPL	159	2,315,450	55.3	11.0	51	1,871,149	44.7	13.6	
400% FPL and above	102	1,911,645	52.4	11.3	54	1,735,785	47.6	12.5	
Insurance (Medical)									.6172
Yes	462	6,589,200	48.9	6.5	252	6,885,670	51.1	6.2	
No	113	920,633	52.3	15.0	34	838,331	47.8	16.5	

Abbreviations/symbols: \* RES, Relative Standard Error (NHANES guidelines recommends a relative standard error less than 30%); # FPL, federal poverty level (Health and Human Services Policy guidelines were used as the measure for FPL)

**Table II.** Differences in Prevalence of Fluorosis  
NHANES 2001-02 and 2011-12

	2001-2002			2011-2012			% difference in fluorosis (2011-12)-(2001-2)	P-value
	N*	Wt. F#	Wt. Column %	N*	Wt. F#	Wt. Column %		
<b>Fluorosis</b>								<.0001
Very mild and above	199	2,269,825	29.7	186	4,835,453	61.3	+31.6%	
Normal/Questionable	387	5,376,229	70.3	104	3,049,593	38.7		
<b>Fluorosis Severity</b>								<.0001
Normal	258	3,806,709	49.8	87	2,459,906	31.2		
Questionable	129	1,569,520	20.5	17	10,206	7.5		
Very mild and above	199	2,269,825	29.7	186	4,835,453	61.3	+31.6%	

Abbreviations: \* N=number; # Wt F=weighted frequency

P-value is based on the Rao-Scott Chi-Square test between the years 2001-02 and 2011-12 with column percentages.

**Table III.** Odds Ratios and 95% Confidence Intervals from Logistic Regression and Multinomial Logistic Regressions on Fluorosis Prevalence  
NHANES, 2001-02 and 2011-12

	Unadjusted Odds Ratio [95% CI*]	P-Value	Adjusted Odds Ratio [95% CI]	P-Value
<b>Fluorosis as mild and above compared with questionable and normal</b>				
Year		<.0001		<.0001
2011-2012	3.60 [2.15, 6.05]		3.85 [2.20, 6.72]	
2001-2002	reference (1.00)		reference (1.00)	
<b>Fluorosis as questionable compared with normal</b>				
Year		0.3149		.3375
2011-2012	0.64 [0.26, 1.57]		0.65 [0.27, 1.59]	
2001-2002	reference (1.00)		reference (1.00)	
<b>Fluorosis as mild and above compared with normal</b>				
Year		<.0001		<.0001
2011-2012	8.25 [4.17, 16.34]		10.75 [4.79, 24.13]	
2001-2002	reference (1.00)		reference (1.00)	

Abbreviations:

\* CI=Confidence Interval

Adjusted Odds Ratio includes adjustments for: sex, race/ethnicity, federal poverty level (Health and Human Services Policy guidelines were used as the measure) and medical insurance.

results from this study. However, the two studies are not fully comparable due to variations in the ages of the children evaluated and the study designs.

It has been noted that there is a lack of available current epidemiologic data on fluorosis in the U.S. which leads to uncertainty about its prevalence and severity. In addition, there is a little data concerning changes in the prevalence of fluorosis over time, especially in regards to the 1994 modification to fluoride supplementation guidelines from the American Dental Association.<sup>16</sup> This study adds additional data points and trends regarding the incidence of fluorosis to consider.

This study had limitations. While the examiners were all calibrated to the same criteria, the gold standard calibration examiner was not the same individual in both of the years studied (2001-2002 and 2011-2012). This discrepancy may have influenced the interpretation of the degree of fluorosis reported.

Strength of this study include the data sources and methodology. NHANES is a well-designed, nationally representative program of studies in which the same criteria were used in 2001-2002 and in 2011-2012. The NHANES studies evaluated full mouth dental fluorosis. It is noteworthy that fluorosis can be described in a number of ways at the tooth or person level, as well as on multiple levels in which it is either dichotomized or exists with several severity levels. The variety of options to evaluate fluorosis can be considered both a strength and a limitation to increasing the knowledge based regarding this condition.

### Policy recommendations

Fluoride is available to many children in their water, toothpaste, varnishes, topical fluoride applications, and foods. Exposure to greater than optimal fluoride levels results in fluorosis. Guidelines for reducing the recommended fluoride supplementation were first introduced in 1994 due to the wider availability of fluoride. In 2015, The Federal Panel on Community Water Fluoridation of the U.S. Department of Health and Human Services recommended that the optimal fluoride level in CWS should be 0.7 mg per liter of water representing an approximately 0.1–0.5 mg per liter reduction for most CWSs.<sup>19</sup> Recommendations have also been made regarding the use of toothpastes containing fluoride. A parent/guardian should brush his/her child's teeth or supervise the child while the child is brushing to prevent the child from swallowing toothpaste. Caries assessment should be the basis for prescribing and recommending high fluoride concentration toothpastes<sup>20</sup> as well as considering all possible sources of fluoride in a child's diet at home and away from home. Other dietary fluoride supplements or prescribed fluoride pharmaceuticals (such as prescription fluoride gels or varnishes) should follow similar caries risk assessments and appropriate guidelines.

## Conclusions

There was a difference of 31.6% in dental fluorosis prevalence recorded in adolescents aged 16 and 17 years between 2012-2011 and 2002-2001. The presence of fluorosis was evaluated in a nationally representative survey by calibrated dental examiners using the modified Dean's fluorosis classification system. Data analysis of the prevalence of fluorosis severity was collapsed to very mild/above vs. normal/questionable due to limited sample sizes in the moderate fluorosis and severe fluorosis categories in 2001-2002 and 2011-2012. Results from this study suggest that the prevalence of dental fluorosis continued to rise despite the 1994 recommendations by the American Dental Association to lower fluoride supplementation. Dental professionals, parents and health communities in general should be aware of incidence of dental fluorosis while not disputing the benefits of fluoride for caries prevention and control.

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## General Dentists' Perceptions of Dental Hygienists' Professional Role: A Survey

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### Abstract

**Purpose:** Changes in dental hygienists' scope of practice in the United States (U.S.) are not independent of general dentists' attitudes and behavior related to dental hygienists' professional roles. The purpose of this study was to assess perceptions and knowledge of general dentists concerning the legally allowable duties of dental hygienists in their state versus the services they provide in their individual practices; the importance of dental hygienists' contributions to the practice; and how well dental hygienists interact with dentists and patients. The relationships between dentists' attitudes, and dental hygienists' actual behavior, the age of the dentist and the number of dental hygienists and dental assistants employed in the practice were also explored.

**Methods:** Survey data were collected from 292 general dentists in the state of Michigan concerning their attitudes and behavior related to dental hygienists' scope of practice.

**Results:** The average number of services dental hygienists provided in the practices surveyed were lower than the average number of services that dental hygienists are legally permitted to provide in the state of Michigan. The higher the importance dentists placed on dental hygienists' clinical and overall contributions to their practice and their patient management skills, the more diagnostic services and therapies the dental hygienists performed. The older the dentists were, the higher they rated the importance of dental hygienists' clinical contributions, their contributions for the provision of patient care, and the more often dental hygienists performed diagnostic and additional procedures.

**Conclusions:** While dentists did not indicate delegating all of the legally allowable dental hygiene duties in their practices, they did indicate having a very high appreciation of the contributions of dental hygienists to their practice. The perceived value of dental hygienists' contributions correlated positively with the number of diagnostic and adjunctive services dentists delegated dental hygienists to perform in their practices.

**Keywords:** dental hygienists, professional role, scope of practice, access to care

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### Introduction

Ever since the publication of the first United States (U.S.) Surgeon General's report on oral health in 2000, it has become common knowledge that certain segments of the U.S. population do not only have higher rates of oral disease, but are also likely to encounter challenges when seeking oral health care services.<sup>1</sup> Individuals from socio-economically disadvantaged and/or ethnic/racial minority backgrounds and those with special health care needs are particularly impacted by access to care barriers. One strategy for addressing the access to oral health care problem is to increase the scope of practice of dental hygienists, while concurrently decreasing the level of supervision by

dentists.<sup>2</sup> There are several ways to achieve such a professional change. One strategy is to increase the extent of dental hygienists' contributions through the adoption of a "direct access" model. This model allows dental hygienists to initiate treatment based on the assessment of a patient's needs without specific authorization of a dentist, treat patients without the presence of a dentist, and maintain a provider-patient relationship.<sup>2,3</sup> Currently, 39 states have adopted policies enabling dental hygienists to provide oral health care to underserved populations through direct access models.<sup>4,5</sup> While these states differ in which treatments dental hygienists are allowed to provide without direct supervision by a dentist, the provision of an oral prophylaxis, dental sealants, and

application of topical fluoride have been included by the majority of the 39 states who use this model.<sup>6</sup> A second approach to utilizing dental hygienists' capabilities to increase access to care is by introducing state-specific policies for indirect supervision by a dentist, such as the Public Act 161 in the state of Michigan.<sup>2</sup> Catlett and Greenlee's comparison of the 50 states' and the District of Columbia's supervision requirements for dental hygienists from 1993 - 2000 versus 2001 - 2011 demonstrated a clear decrease in the required levels of supervision for 11 types of services over this time span.<sup>7</sup>

Historically, efforts to expand dental hygienists' scope of practice have faced opposition from dentists,<sup>8</sup> and changes in dental hygienists' scope of practice in the U.S. are clearly not independent of general dentists' attitudes and behavior concerning dental hygienists' professional role. Reactions to the most recent changes in the dental hygiene profession reducing the need for direct and indirect supervision, in addition to the introduction of the dental therapist model, have been mixed.<sup>9-11</sup> Some investigators have argued that negative reactions might be due to concerns regarding the quality of care provided by dental hygienists or to concerns about a competitive advantage of lower costs of care provided by dental hygienists that could harm dentists' earning potential.<sup>8</sup> However, it is also possible that the resistance stems from the fact that dentists do not understand dental hygienists' scope of practice and the complex set of services they are able to provide. Research dating back to 1991 has shown that dental hygienists were not being utilized to provide their full range of professional services.<sup>12</sup> There is a gap in the literature in regards to data analyzing dentists' knowledge of the legally allowable dental hygiene duties in their state and whether this knowledge level correlates with what duties they ask the dental hygienists in their own practices to perform. Exploring whether this relationship exists in context with the value dentists place on the services and contributions dental hygienists make in the dental practice, could provide insight into dentists' attitudes towards efforts to expand the scope of practice and decrease direct supervision duties. Insights gained concerning dentists' knowledge and attitudes may prove beneficial in creating a political support base for efforts to change dental practice acts.

The purpose of this study was to assess general dentists' perceptions and knowledge of what dental hygienists are legally allowed to perform in their state versus what services they actually provide in their individual practice; the importance of dental hygienists' contributions to their practice; and how well dental hygienists interact with dentists and patients. Relationships between dentists' attitudes, their age and number of dental hygienists and dental assistants employed in their practices and dental

hygienists' actual duties in the dental practice were also examined.

## Methods

Survey data were collected from general dentists who were all members of the Michigan Dental Association. This study was determined to be exempt from Institutional Review Board (IRB) oversight by the IRB for the Behavioral and Health Sciences, University of Michigan, Ann Arbor, MI. A draft version of the survey was pilot tested with six general dentists working in private practice settings and their feedback was used to finalize the survey. The MDA provided a membership list of approximately 6,000 members; a random number generator was used to select the 900 dentists who received the postal mailed, paper-pencil survey. The mailing included the survey and a cover letter from the academic dean of the University of Michigan School of Dentistry explaining the purpose of the anonymous study and an invitation to participate. A stamped, self-addressed return envelope was included in the mailing.

The survey consisted of four sets of questions. Part 1 included questions concerning the respondents' socio-demographic background, education, and practice characteristics. Part 2 consisted of a list of twenty-six procedures dental hygienists are legally allowed to perform in the State of Michigan. For each procedure listed, respondents were asked (A) if dental hygienists are able and permitted to provide this treatment, and (B) if dental hygienists in their own practice were currently performing these procedures. The answer alternatives for the questions regarding legally allowable procedures were "Yes", "No", and "Unsure", while the answer alternatives to the questions regarding what they allowed in their own practices were either "Yes" or "No". Questions regarding dental hygienists' contributions to the practice were included in Part 3. The first eight questions asked respondents to indicate on a 5-point scale (1="not at all important" to 5="very important") how important dental hygienists' input was for treatment and diagnostic considerations in their dental practice. Categories included diagnosis of periodontal disease, clinical caries, radiographic findings, oral cancer screening, temporomandibular joint dysfunction, and mucositis and explanations of treatment processes and outcomes. Six additional items regarding dentists' perceptions of the dental hygienists' contributions to their practice had a Likert-style response format, with 5-point answer scales ranging from 1="disagree strongly" to 5="agree strongly." Part 4 included 3 items pertaining to interactions between dentists and dental hygienists and 7 items regarding dental hygienists' patient management skills.

## Statistical analyses

Responses were entered into an SPSS data file (IBM Corp. Released 2013. SPSS Statistics for Windows.

**Table I.** Demographic and practice characteristics of Michigan dentists

	<b>Frequency (%) N=292 (100%)</b>
<b>Background characteristics</b>	
Gender:	
- Male	217 (75%)
- Female	74 (25%)
Age:	
Mean (SD) / Range	52.23 (12.50) / 26-83
Ethnicity/Race:	
- European American	264 (95%)
- Non-European American	15 (5%)
Year of dental school graduation:	
Mean (SD) / Range	1990 (12.9)/1962-2014
<b>Practice characteristics</b>	
Community type: - Small town	95 (32%)
- Moderate city	84 (29%)
- Suburb of a large city	66 (23%)
- Rural	32 (11%)
- Large city	14 (5%)
Practice type: <sup>1</sup> - Solo practice	91 (31%)
- Owner of practice	106 (36%)
- Partnership	43 (15%)
- Group practice	36 (12%)
- Associate	28 (10%)
- Corporate	14 (5%)
- Community dental clinic	9 (3%)
- Academic	6 (2%)
Number of employed:	
- Hygienists: Mean (SD) / Range	3 (2.8) / 0-40
- Assistants: Mean (SD) / Range	3 (2.2) / 0-15
- Other staff: Mean (SD) / Range	3 (1.9) / 0-11
Hours Worked:	
Mean (SD) / Range	31.27 (7.728) / 3-60
Number of patients treated per week:	
Mean (SD)/ Range	61 (46.4) / 0-300
Percentage of patients from:	
- Upper income class: Mean (SD) / Range	15 (16.3) / 0-99%
- Middle income class: Mean (SD) / Range	63 (20.7) / 0-100%
- Lower income class: Mean (SD) / Range	25 (22.0) / 0-100%
Primary payment type: <sup>1</sup>	
- Insurance	235 (80%)
- Self-pay	115 (39%)
- Medicaid	9 (3%)

Legend:

<sup>1</sup> Multiple answers were possible and the sum of percentage can therefore exceed 100%.

Version 22. Armonk, NY: IBM Corp). Descriptive statistics such as frequency distributions, means and standard deviations were computed to provide an overview of the responses. A factor analysis (Extraction Method: Principal Component Analysis; with Varimax Rotation) of the items included in Parts 3 and 4 of the survey was used to determine which questions loaded on the same factors. Indices were computed based on the results of the factor analysis. Cronbach alpha coefficients were used to determine the inter-item consistency of the indices. Inferential statistics determined whether Pearson correlation coefficients were significant ( $p < .05$ ).

## Results

Responses were obtained from 292 ( $n=292$ ) of the randomly selected MDA members ( $n=900$ ) who received a postal mailed survey for a response rate of 32%. Table 1 shows that the majority of respondents were male (75%), from European American backgrounds (95%), ranging in age from 26-83 years (mean=52.23 years) and had graduated from dental school between 1962 and 2014. About one third (32%) practiced in a small town, 29% in a moderate sized city, 23% in a suburb of a large city and 11% in a large city. The highest percentage of responses (36%) came from dentists who were practice owners, followed by 31% indicating that they worked in a solo practice setting, 15% who worked in a partnership, 12% who worked in a group practice, and 10% who were associates. The remainder were employed in corporate practices (5%), followed by community dental clinics (3%), and academia (2%). The number of dental hygienists employed ranged from 0-40 (mean=3), the number of assistants ranged from 0-15 (mean=3) and the number of other staff members ranged from 0-11 (mean=3). Respondents worked on average 31 hours per week and



treated an average of 61 patients per week. Dental insurance was the primary payment type for 80% of the respondents, followed by 39% self pay and 3% Medicaid. Twenty-two percent of the respondents reported caring for low-income patients.

Respondents' knowledge of the 26 different allowable duties for dental hygienists in Michigan and the actual duties that were performed in their individual practices are presented in Table II. The 26 services were categorized as preventive, diagnostic, patient behavior-related, pain management-related or related to supplemental/technical therapies or other services. Preventive services such as dental prophylaxis, scaling/root planing, periodontal maintenance, application of topical fluorides were provided by 99% of the dental hygienists in the practices surveyed. However, placement of dental sealants was only performed by 69% of the clinicians. The majority of dental hygienists (98%) completed periodontal chartings, 98% obtained medical histories and 98% took radiographic images. Recording patient vital signs and caries risk assessment was performed by 81% of dental hygienists, oral cancer screenings by 75%, intra and extra oral examinations by 68%, and radiographic interpretation by 68%. Nearly all dental hygienists (99%) were engaged in some sort of patient education. However, only 71% were involved in nutritional counseling and 61% in tobacco cessation counseling. The percentage of dental hygienists who applied desensitizing agents was 87%, while 70% administered local anesthesia, and 60% nitrous oxide sedation. Additional procedures allowed in the state of Michigan such as taking alginate impressions (52%), pouring cast models (36%), removing restoration overhangs (26%), adjusting restorations (1%), tooth whitening (40%), suture removal (21%) and supportive orthodontic treatment (15%) were performed by significantly fewer dental hygienists.

Dentists' responses concerning the importance of dental hygienists' input for dentists' patient care and the dental hygienists' contributions to the practice are shown in Table III. Overall, the vast majority of respondents agreed that dental hygienists play a very important (91%) role as a member of the dental team. When asked about the importance of the dental hygienists' input into different types of clinical practice behaviors, the majority of the respondents viewed the dental hygienists' input into the diagnosis of periodontal disease (85%) and the explanation of the treatment process and outcomes (66%) as being very important. However, fewer than half rated the role of dental hygienists in the diagnoses of oral cancer (47%), clinical caries (34%), radiographic findings (34%), mucositis (30%), and temporomandibular joint disorders (23%) as being very important. An index of clinical competence was computed by averaging the responses to these 7 items, and the mean response was 4.07 on a 5-point

scale, demonstrating a positive rating of dental hygienists' clinical competence.

Dental hygienists' contributions to the respondents' practices were also viewed as positive. The majority of respondents considered dental hygienists to be well integrated into their practices (67%), that they worked well in a team environment (66%), and required little supervision (67%). Additionally, the majority agreed that dental hygienists managed their time well, were responsible for determining appropriate patient recall, and were capable of determining appropriate individualized treatment (Table III).

Table IV shows that the majority of respondents either agreed (28%) or strongly agreed (68%) that they valued the recommendations of dental hygienists in their practices; that they were comfortable speaking with dental hygienists where patient care is concerned (agreed:17%/strongly agreed:80%), and thought dental hygienists benefitted the business aspects of their practice (agreed:19%/strongly agreed:59%). Dentists' perceptions of the dental hygienists' patient management skills were also positive with the majority either agreeing or strongly agreeing that dental hygienists in their practices effectively created behavior change in patients (agreed: 39%/strongly agreed: 46%). Patient rapport, conflict resolution, specialized skills and patient communication skill responses are shown in Table IV.

An overview of the Pearson correlation coefficients for the relationships between the four attitudinal indices described in Tables III and IV and the six sum scores of dental hygienists' performed professional services (preventive services; diagnostic services; patient behavior modification; pain management; supplemental services and other services) is provided in Table V. The findings demonstrate an interrelationship in the respondents' attitudes. The higher the respondents rated their dental hygienists' clinical contributions to their practice, the more they considered them to make contributions to the practice overall ( $r=.34$ ;  $p<.001$ ), have better interactions with dentists ( $r=.40$ ;  $p<.001$ ), and better patient management skills ( $r=.34$ ;  $p<.001$ ). Attitudinal responses were also correlated with the different types of services assigned to dental hygienists by these respondents. While all four attitudinal indices were positively correlated with assigning diagnostic and supplemental services, only the importance of dental hygienists' clinical contributions was correlated with assigning them to engage in other services, and positive attitudes concerning dental hygienists' patient management skills were only positively correlated with patient behavior modification.

Relationships between respondents' age, the number of dental hygienists and assistants employed with the four attitudinal indices and the six sum scores of services the dental hygienists actually provide are

**Table II.** “Yes” response data regarding services in the scope of practice for dental hygienists in Michigan and the services actually provided in the workplace

Type of services: Preventive services	Yes - In Michigan:	Yes - In workplace	Contingency coefficient
Dental prophylaxis	100%	99%	.374***
Scaling/root planing	100%	99%	.006
Application of fluoride	100%	99%	.008
Periodontal maintenance	99%	99%	.269***
Placing dental sealants	95%	69%	.285***
Preventive services sum score: <sup>1</sup> Mean (SD)	4.91 (.390)	4.63 (.565)	p<.001 <sup>2</sup>
<b>Diagnostic services</b>			
Periodontal charting	99%	98%	.015
Taking medical/dental history	99%	98%	.288***
Exposure of radiographs	99%	98%	.365***
Taking patient vitals	97%	81%	.275***
Caries risk assessment	90%	81%	.409***
Oral cancer screening	88%	75%	.556***
Intra oral exam	87%	68%	.592***
Interpret radiographs	73%	63%	.556***
Diagnostic services sum score: <sup>1</sup> Mean (SD)	7.33 (1.042)	6.53 (1.371)	p<.001 <sup>2</sup>
<b>Patient behavior modification</b>			
Patient education	99%	99%	.012
Nutritional counseling	99%	71%	.438***
Tobacco cessation counseling	87%	61%	.415***
Patient behavior modification score: <sup>1</sup> Mean (SD)	2.74 (.603)	2.29 (.827)	p<.001 <sup>2</sup>
<b>Pain management</b>			
Applying desensitizing	98%	87%	.357***
Administer local anesthesia	93%	70%	.335***
Administer nitrous oxide	81%	60%	.475***
Pain management sum score: <sup>1</sup> Mean (SD)	2.71 (.582)	2.16 (.867)	p<.001 <sup>2</sup>
<b>Supplemental Therapies</b>			
Taking alginate impressions	89%	52%	.281***
Pouring cast models	87%	36%	.089
Removal of overhangs	42%	26%	.531***
Restoration adjustment	21%	1%	.363***
Supplemental Therapy sum score: <sup>1</sup> Mean (SD)	3.09 (1.617)	2.39 (1.082)	p<.001 <sup>2</sup>
<b>Other services</b>			
Tooth whitening	76%	40%	.419***
Removal of sutures	65%	21%	.332***
Supportive orthodontic treatment	35%	15%	.488***
Other services sum score: <sup>1</sup> Mean (SD)	1.73 (1.214)	.75 (.854)	p<.001 <sup>2</sup>

Legend: \*\*\* = p<.001

<sup>1</sup> All sum scores were computed by adding 1 point for each “Yes” response.

<sup>2</sup> A dependent sample t-test found that the two means are significantly different.

summarized in Table VI. The findings demonstrate that the older the respondents were, the more they valued the clinical contributions of dental hygienists ( $r=.21$ ;  $p<.001$ ), and the more diagnostic procedures ( $r=.13$ ;  $p<.05$ ), technical services ( $r=.15$ ;  $p<.05$ ) and other services the dental hygienists performed ( $r=.13$ ;  $p<.05$ ). The number of dental hygienists and dental assistants employed in dentists' practices did not correlate with their attitudes. However, the number of dental hygienists negatively correlated with the number of additional services ( $r=-.13$ ;  $p<.05$ ) they provided in the respondents' practices. The number of dental assistants employed positively

correlated with the number of pain management services ( $r=.21$ ;  $p<.001$ ) dental hygienists provided, but negatively with the sum of other services provided ( $r=-.14$ ;  $p<.05$ ).

## Discussion

Dental hygienists have the potential to make significant contributions to resolving the access to dental care challenges of underserved populations in the U.S.<sup>8</sup> Current advancements in the profession including increases in the number of direct access states<sup>4,5,9-11</sup> and the development of specialized programs with increased responsibilities and pro-

**Table III.** Attitudinal responses concerning the importance of dental hygienists' input for patient care and contributions to the dental practice

<b>How important is:</b>	<b>1<sup>1</sup></b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>Mean (SD)</b>
the role of the dental hygienist as a member of your dental team?	3%	1%	0%	5%	91%	4.80 (.776)
<b>Clinical competence-Importance of RDH in:</b>	<b>1<sup>2</sup></b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>Mean (SD)</b>
Diagnosis of periodontal disease	0%	1%	3%	11%	85%	4.80 (.527)
Explanation of treatment process and outcomes	1%	1%	7%	26%	66%	4.56 (.688)
Diagnosis of oral cancer	2%	4%	23%	24%	47%	4.09 (1.025)
Diagnosis of clinical caries	1%	6%	21%	31%	41%	4.07 (.954)
Diagnosis of radiographic findings	1%	9%	27%	28%	34%	3.85 (1.035)
Diagnosis of mucositis	5%	9%	28%	28%	30%	3.70 (1.145)
Diagnosis of temporomandibular joint dysfunction	5%	13%	36%	23%	23%	3.47 (1.123)
Clinical competence Index: (alpha=.876) <sup>3</sup> ; Mean (SD) Range	—	—	—	—	—	<b>4.07 (.722); 1.29-5</b>
<b>Dentists' perceptions of RDH contributions to practice</b>	<b>1<sup>3</sup></b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>Mean (SD)</b>
RDH is well integrated into practice.	0%	1%	3%	27%	67%	4.61 (.628)
RDH works well in team environment.	0%	2%	5%	27%	66%	4.56 (.693)
RDH requires little supervision.	1%	3%	4%	25%	67%	4.53 (.810)
RDH manages time well.	1%	5%	16%	40%	39%	4.12 (.883)
RDH is responsible for determining appropriate patient recall.	6%	9%	14%	27%	44%	3.93 (1.225)
RDH is capable of determining appropriate individualized tx.	2%	9%	21%	33%	35%	3.91 (1.041)
Contribution to practice Index: (alpha=.776) <sup>3</sup> ; Mean (SD) Range	—	—	—	—	—	<b>4.28 (.622); 2.17-5</b>

Legend:

<sup>1</sup> Response range: 1 = not at all important to 5= very important.

<sup>2</sup> Response range: 1 = disagree strongly to 5 = agree strongly.

<sup>3</sup> Indices were computed by averaging the responses to the single items.

**Table IV.** Responses concerning the interactions between dental hygienist(s) and general dentist(s) and perceptions' of hygienists' patient management skills

<b>Dentists' perceptions of RDH-dentist interaction</b>	<b>1<sup>1</sup></b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>Mean (SD)</b>
Value the recommendations of the RDH.	1%	1%	2%	28%	68%	4.64 (.588)
RDH benefits business aspect of practice	4%	4%	14%	19%	59%	4.25 (1.085)
Comfortable speaking with RDH where patient care is involved	1%	1%	2%	17%	80%	4.75 (.562)
Interaction Dentist-RDH Index <sup>2</sup> (alpha=.623); Mean (SD) Range	—	—	—	—	—	<b>4.55 (.582); 1-5</b>
<b>Dentists' perceptions of RDH patient management skills</b>	<b>1<sup>2</sup></b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>Mean (SD)</b>
RDH can effectively create behavior change in patients.	1%	2%	13%	39%	46%	4.28 (.792)
RDH establishes good patient rapport.	1%	1%	0%	21%	77%	4.72 (.609)
RDH manages conflict effectively.	1%	5%	19%	45%	29%	3.95 (.910)
RDH has specialized skill set.	2%	3%	12%	34%	49%	4.25 (.915)
RDH is a lifelong learner.	1%	2%	8%	33%	56%	4.41 (.797)
RDH has effective patient communication skills	1%	1%	5%	39%	55%	4.46 (.686)
RDH is confident in all aspects of patient care	1%	4%	19%	39%	38%	4.08 (.900)
RDH Patient management skills Index <sup>2</sup> (alpha=.852); Mean (SD) Range	—	—	—	—	—	<b>4.32 (.575); 1.43-5</b>

Legend:

<sup>1</sup> Answers ranged from 1= strongly disagree to 5= strongly agree

<sup>2</sup> The indices were computed by averaging the responses to the single items.

professional autonomy as demonstrated in the dental therapist model,<sup>13-15</sup> are trends that will continue. However, a moderating factor to this progress has been the input of dentists. Their understanding of dental hygienists' scope of practice along with their attitudes and behavior related to their professional interactions with dental hygienists are critical factors influencing their acceptance of changes in supervision levels and scope of practice of dental hygienists. Insight into the basis for their knowledge and attitudes can serve to inform the necessary educational interventions and guidance for how dental schools and professional organizations provide information aimed at increasing awareness of the role that dental hygienists play.

While over 90% of the respondents knew that dental hygienists in Michigan could provide all 5 of the preventive services, 5 out of 8 of the diagnostic services, and 2 out of the 3 behavior and pain management strategies respectively, less than 90% were aware that dental hygienists in the state of Michigan could also perform the other 12 of the 26 services listed. This lack of knowledge

concerning dental hygienists' full scope of practice indicates a need for change. Dental school programs should explore strategies to ensure that graduates are educated about dental hygienists' scope of practice in order to work with them effectively. A discussion of whether such efforts should be solely focused in dental education settings or whether interprofessional education (IPE) efforts<sup>16-20</sup> would be best suited to achieve optimal dental education goes beyond the scope of this paper. Additionally, continuing education programs from both dental and dental hygiene professional organizations can serve to provide ongoing updates on any changes in regards to dental hygienists' scope of practice as well as full utilization of the legally allowable duties. Data from this study showed that the more knowledge dentists had regarding the full spectrum of duties including the administration of nitrous oxide, removal of overhangs and adjusting restorations among other services, the more likely they were to delegate these services to a dental hygienist.

In addition to understanding dental hygienists' scope of practice, dentists' attitudinal responses

**Table VI.** Correlations between dentists' age, and the number of dental hygienists and dental assistants employed and the attitudinal and behavioral indices

Attitudinal indices	Age <sup>1</sup>	# dental hygienists	# dental assistants
RDH – Clinical contributions	.21***	.01	.03
Contributions to practice	-.04	.00	-.03
Interactions RDH -Dentist	.08	.02	-.06
RDH: Patient management skills	.07	.05	.02
<b>RDH – Professional behavior</b>			
Sum score "Preventive/non-surgical DH does"	-.05	.01	.00
Sum score "Diagnostic procedures DH does"	.13*	.06	.07
Sum score "Patient behavior change DH does"	-.05	-.05	.05
Sum score "Pain management DH does"	-.02	.01	.21***
Sum score "Supplemental therapies DH does"	.15*	-.09	-.10
Sum score "Other services DH does"	.13*	-.13*	-.14

Legend: Note: \*p = <.05; \*\* p <.01; \*\*\* p<.001

<sup>1</sup> Pearson correlation coefficients were used to determine associations between indices and dentist characteristics.

concerning the value of their contributions to a dental practice should be considered. Dentists' attitudes towards dental hygienists in this study were very positive. However, correlations between these positive attitudes and the actual procedures that were delegated to dental hygienists were not consistently high. Exploring more explicit connections between dentists' attitudes and specific types of professional behaviors such as pain management strategies and tobacco cessation counseling might be achieved through team-based IPE. Clinical or community-based IPE experiences with dental and dental hygiene students working collaboratively could result in increased positive attitudes concerning dental hygienists' role and contributions to patient care.

Results from this survey showed that the respondents were much more likely to delegate preventive services to the dental hygienist over the adjunctive services. This may be due to the fact that these were billable services that generate incrementally more revenue than the other services. In addition, dental assistants, have overlapping scope of practice for diagnostic procedures such as taking alginate impressions and radiographic imaging. When considering why some respondents may not be delegating local anesthesia and nitrous oxide to dental hygienists, the lower rates

may be due to the relatively recent addition of these expanded duties in the state of Michigan (2002 and 2004 respectively).

The relationship between the age of the dentist and their appreciation of the clinical contributions of dental hygienists is a finding that deserves further discussion. Data from this study demonstrated that the older the dentists were, the more they appreciated the clinical contributions of dental hygienists' and the higher their involvement in diagnostic and adjunctive services. Younger respondents demonstrated lower levels of appreciation and were less likely to utilize all of the duties dental hygienists are allowed to perform.

The assumption that the more recent graduates would appreciate the role of dental hygienists more and involve them in a wider range of services did not bear true in this study and raises the question whether more IPE and interprofessional collaboration opportunities between dental students and dental hygiene students would change these perceptions and increase the full utilization of dental hygienists.

This study had several limitations. There was a potential self-selection bias of respondents, with respondents being more favorable towards a decrease in supervision of dental hygienists and an increase in the scope of practice of dental hygienists as compared to non-respondents. Additionally, the relatively small number of respondents does not allow for sub-group comparisons such as whether dentists who are practice owners differ in their responses from dentists working in community dental clinic settings. Future research should aim at increasing the number of respondents to allow more in-depth analyses. Results from this study are limited to the state of Michigan. A national survey would provide a basis for generalizations of the findings.

## Conclusions

The majority of the dentist respondents from the State of Michigan reported having knowledge of the range of preventive and diagnostic services, pain management and patient behavior modification strategies a dental hygienist is allowed to provide. However, gaps in knowledge regarding the full scope of dental hygiene practice indicate a need for future educational efforts in dental school settings and in continuing education courses for practicing dentists.

**Table V.** Correlations between attitudinal indices and dental hygienists' professional behavior

Attitudinal indices <sup>1</sup>	Dental hygienist's clinical contributions	Dental hygienist's contributions to practice	Interactions dental hygienist/dentist	Dental hygienists' patient management skills
RDH – Clinical contributions	1	.34***	.40***	.34***
Contributions to practice	.34***	1	.64***	.71***
Interactions RDH - dentist	.40***	.64***	1	.65***
RDH: Patient management skills	.34***	.71***	.65***	1
<b>RDH – Professional behavior</b>				
Preventive services	.08	.18**	.16**	.12
Diagnostic services	.35***	.23***	.19**	.26***
Patient behavior modification	.09	.11	.03	.14*
Pain management	.11	.14*	.00	.10
Supplemental therapies	.21***	.17**	.15*	.22***
Other services	.17**	.11	.06	.08

Legend: \*p = <05; \*\* p = <.01; \*\*\* p = <.001

<sup>1</sup> Pearson correlation coefficients were used to determine associations between the indices.

The range of services that dental hygienists actually provided in the dental practices of the respondents highly correlated with the dentists' beliefs regarding the allowable duties for dental hygienists. Overall, respondents had exceptionally positive attitudes regarding both the clinical and general contributions dental hygienists made to their practices, their patient management skills, and their interpersonal interactions in the dental setting. However, these positive attitudes did not translate into full utilization of the dental hygienists' scope of practice in the state of Michigan. Interprofessional education in dental school setting might provide the basis for improving dental team members' knowledge about each other's scope of practice, attitudes and professional competencies.

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## Factors Influencing Dental Hygienists' Decisions to Pursue Doctoral Degrees

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### Abstract

**Purpose:** To identify the factors that have influenced dental hygienists to pursue post-graduate education opportunities, specifically dental (DDS, DMD) as compared to academic doctoral degrees, such as doctor of philosophy (PhD) or doctor of education (EdD).

**Methods:** A convenience sample of dental hygienists with doctoral degrees were identified from multiple sources (n=140) and sent a 27-item web-based survey. Univariate logistic regression analysis was used to explore the influence of independent variables (respondents' demographic and personal characteristics, influential persons and experiences, encouraging and motivating factors) on the respondents' decision to pursue either a dental or an academic doctoral degree.

**Results:** Of the 140 potential participants, 69 (n=69) responded (49% response rate): 17 dental degree respondents, 46 academic degree respondents. In contrast to academic degree respondents, those with dental degrees graduated from dental hygiene programs more recently (p=0.03), spent less time working as a dental hygienist (p=0.01), considered themselves mechanically inclined (p=0.03), and preferred to learn a new skill rather than read about a current research study (p=0.002). Both groups agreed that working one-on-one with people was important to career satisfaction. Dental degree respondents were more likely to have been influenced or encouraged to pursue dentistry by dentists (p=0.01) and family (p=0.004). Academic degree respondents were more likely to have had experiences with a researcher/scientist (p=0.004) or had been influenced by an educator (p=0.01). Only 40% of all respondents reported that dental hygiene instructors were instrumental in encouraging their advanced education.

**Conclusion:** Dental hygienists possessing characteristics similar to the academic degree respondents in this study should be encouraged to pursue academic doctoral education, providing the necessary skills to advance the dental hygiene profession.

**Keywords:** dental hygiene education, faculty development, professional development, postgraduate education

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### Introduction

Increasing numbers of dental hygienists have been advancing their education to the doctoral level in recent years with the majority pursuing doctoral degrees in dentistry as a Doctor of Dental Surgery (DDS)/Doctor of Medicine in Dentistry (DMD), or in education/research as a Doctor of Education (EdD) or Doctor of Philosophy (PhD). Multiple factors appear to have led dental hygienists to pursue doctoral education in their respective specialty areas and the subsequent career pathways.

Previous studies of students choosing to pursue dentistry have reported a desire to help others, regular hours and flexible work schedules, independence/autonomy, financial benefits, job security, and the

desire to use one's practical/artistic skills as motivations for this career choice.<sup>1-5</sup> Students seeking research-oriented doctoral degrees were reportedly motivated by learning and discovering new things, thinking and acting independently, and helping others, albeit indirectly, through research. They also identified the greater career mobility that a doctorate degree can provide, as a factor.<sup>6,7</sup> In a study of women's career choices conducted by Edmunds et al., female faculty members reported a greater interest in teaching over research, expressing that teaching enabled greater flexibility and enhanced their work-life balance.<sup>8</sup> These personal preferences and interests may parallel those that have attracted dental hygienists to pursue their specific doctoral degree and career pathway.



Both dental and academically based education/research doctoral career pathways address oral health-related issues and play critical roles in maintaining the oral health of the public. However, the education/research pathway may potentially offer greater benefits towards the overall advancement of the dental hygiene profession. Dental hygienists educated at the doctoral level may be better able to relate more equitably with others holding doctorates in health-related disciplines, facilitating interprofessional collaboration among health care professions.<sup>9</sup> Additionally, dental hygienists with academically based doctorate degrees may be more focused on conducting the discipline-specific research to expand the dental hygiene body of knowledge, and be better able to attract the necessary funding to support large-scale studies for oral health promotion and disease prevention.<sup>9</sup> Matriculation through doctoral educational programs prepares students with the skills and resources to conduct hypothesis-driven research; it is less likely that dental hygienists holding dental degrees would have the same focus.

A retrospective analysis of the motivational factors influencing dental hygienists who have pursued doctoral degrees, both dental and academic, may help identify distinguishing personal characteristics and interests as well as the types of experiences that have played key roles in their career pathways. Counselors and mentors might be able to use these characteristics to identify dental hygiene students and practitioners and actively encourage them to consider postgraduate degrees in research and academia. Personal contact with established educators and scientists could exemplify the advantages of an education or research-focused career, as well as providing teaching and research opportunities particularly for individuals who had not previously considered this pathway. Increasing the numbers of dental hygienists in research and academia at the doctoral level has the potential to significantly impact the advancement of the profession. The purpose of this study was to identify the factors influencing dental hygienists to pursue post-graduate education opportunities, specifically dental (DDS, DMD) degrees as compared to academic doctoral degrees, such as doctor of philosophy (PhD) or doctor of education (EdD).

## Methods

This cross-sectional study, using a quantitative web-based survey, was approved by the Institutional Review Board of the University of California, San Francisco (IRB# 15-18028), as exempt. Dental hygienists who had earned doctoral degrees (dental and academic) were identified as the target study population. Names and email addresses of the convenience sample of 140 (n=140) were compiled from a variety of resources including scholarly journal editorial review boards, authors of professional publications, and professional contacts.

The survey instrument consisted of 26 quantitative, close-ended questions and one qualitative, open-ended question regarding personal characteristics, interests, influences and life experiences. Survey items were developed following extensive reviews of previous research and discussions with dental hygienists holding doctoral degrees. The relevant experts included 3 dental hygienists with EdD, PhD, or DDS degrees, 2 dentists, one of whom also held a PhD. Items were modified according to their feedback. The survey was then pre-tested for clarity and comprehension by 5 dental hygiene master's degree candidates.

One hundred forty email addresses were entered into Qualtrics™ survey research software program, which also hosted the survey instrument. An email message containing a letter of informed consent and a link to the survey was sent to potential participants. Respondents selecting the survey link indicated their informed consent. After the initial invitation, three reminders were sent to non-responders over a course of three months. The survey remained active for a four-month period during the spring and summer of 2016. Qualtrics tabulated the responses and calculated the response frequency (percentage) for each survey item.

Respondents were separated into two categories depending upon whether the respondents had pursued a doctoral degree (PhD, EdD, or other), termed academic degree or whether they had pursued a DDS or DMD, termed dental degree. Univariate logistic regression analysis was used to explore the influence of the independent variables (respondents' demographic characteristics, interests and characteristics, influential people and observation/work experiences, encouraging and motivating factors for advanced education, and satisfaction with working as a clinical dental hygienist) on the primary outcome (respondents' choice of either an academic or dental degree). The magnitude of the association between the primary outcome and independent variables were reported as unadjusted odds ratios with corresponding 95% confidence interval. Statistical analyses used SAS version 9.4 (SAS Institute, Cary, NC). All statistical tests provided two-sided p-values, and p-values equal to or less than 0.05 were considered statistically significant.

Responses to the one open-ended item regarding the participant's motivation to earn a doctoral degree and to the "other" options in the close-ended questions were reviewed to identify patterns of responses and categorized into themes.

## Results

Of the 140 potential participants, 69 (n=69) responded for a 49% response rate. Sixty-three respondents specified the type of doctoral degree they earned: 17 had earned a dental degree (22%) and

46 (67%) had a non-dental academic degree. Of the non-dental degreed, 22 had a PhD in various subjects (35%), 16 an EdD (25%), and 8 respondents had earned other types of doctoral degrees (13%). Of the eight who specified "other", their degrees included Doctor of Health Education, Doctor of Public Health, and Doctor of Health Sciences. The non-dental degree respondents totaled 46 or 67% of the 63 respondents specifying their doctoral degree. Ninety-one percent of the respondents were female. Respondents selected as many current employment positions as applicable, with no distinction between full-or part-time status. Sixty-five percent of the dental degree respondents were employed in private practice, 21% at community clinics, and 43% at an educational program. Ninety-six percent of respondents with an academic degree were currently working at education institutions as either faculty (47%) or as administrators (49%).

Results displayed in Table I show that a significantly higher percentage of the respondents who had graduated from their entry-level dental hygiene programs during the years 2006 and 2010 had earned dental degrees versus academic degrees ( $p=0.03$ ). Approximately half of the respondents reported that their parents' terminal degrees were a high school diploma or less. The fathers of nearly 30% of the dental degree respondents had earned a doctoral degree. Time spent working as a dental hygiene clinician before earning a doctoral degree was statistically greater ( $p=0.01$ ) for those that earned academic degrees than for those with dental degrees (Table I).

Dental degree respondents were more likely to consider themselves mechanically inclined than those with academic degrees ( $p=0.03$ ) (Table II). More of the academic degree respondents preferred to read current research studies than to learn a new skill ( $p=0.002$ ). Respondents with dental and academic degrees both agreed that working one-on-one with people was important to career satisfaction.

All dental degree respondents agreed they wanted to help people by providing treatment on an individual

**Table I.** Demographic characteristics of respondents

Characteristics/Experience	Respondent's Degree Type	
	Dental % (n)	Academic % (n)
<b>Entry level Dental Hygiene Program Graduation Year</b>		
1955-1975	6% (1)	29% (13)
1976-1985	31% (5)	40% (18)
1986-1995	19% (3)	20% (9)
1996-2005	19% (3)	4% (2)
2006-2010*	25% (4)	6% (3)
<b>Father's Terminal Degree</b>		
none/high school diploma	24% (4)	49% (22)
associate's degree	12% (2)	9% (4)
bachelor's degree	18% (3)	18% (8)
master's degree	18% (3)	16% (7)
doctoral degree	29% (5)	9% (4)
<b>Mother's Terminal Degree</b>		
none/high school diploma	65% (11)	54% (24)
associate's degree	6% (1)	20% (9)
bachelor's degree	24% (4)	11% (5)
master's degree	6% (1)	11% (5)
doctoral degree	0	4% (2)
<b>Time spent working in clinical dental hygiene before entering doctoral degree program</b>		
0 years	18% (3)	2% (1)
1-4 years	29% (5)	25% (11)
5-9 years	24% (4)	18% (8)
10-14 years	24% (4)	16% (7)
15-30 years*	6% (1)	39% (17)
<b>Time spent in non-clinical roles before entering doctoral degree program</b>		
0 years	76%(13)	24% (11)
1-3 years	24% (4)	9% (4)
4-14 years**	0	38% (17)
15-25 years**	0	29% (13)

\*Statistically different responses between degree types ( $p<0.05$ ) based on logistic regression analysis, corresponding odds ratio presented in Table VI

\*\*Statistically different responses between degree types could not be determined by logistic regression due to the presence of zeroes

basis, which differed significantly ( $p=0.007$ ) from the academic group (Table II). Respondents with academic degrees were more likely than those with dental degrees to envision employment at an educational institution ( $p<0.0001$ ) and to prefer helping people by being involved in policy changes that affect society as a whole ( $p=0.002$ ) and by becoming involved in educating future generation of dental professionals ( $p=0.03$ ). Dental, more than

academic, degree respondents reported desiring regular work hours ( $p=0.0003$ ).

Most respondents reported receiving encouragement to pursue a doctorate in the type of degree they had ultimately selected (Table III). Respondents with dental degrees had been encouraged to earn degrees in dentistry ( $p<0.0001$ ), while those with academic degrees had been encouraged to earn a doctorate an area outside of dentistry ( $p=0.0003$ ). Only

**Table II.** Interests and characteristics of respondents

Interest/Characteristic	Degree	Agree % (n)	Neutral % (n)	Disagree % (n)	Total (n)
I consider myself mechanically inclined*	Dental	82% (14)	18% (3)	0	17
	Academic	57% (26)	22% (10)	22% (10)	46
I prefer doing hands on projects rather than reading books	Dental	32% (6)	41% (7)	24% (4)	17
	Academic	31% (14)	43% (20)	26% (12)	46
I prefer to read about a current research study rather than learn a new skill*	Dental	0	24% (4)	77% (13)	17
	Academic	17% (8)	61% (28)	22% (10)	46
Working one-on-one with people is important to career satisfaction	Dental	94% (16)	6% (1)	0	17
	Academic	83% (37)	16% (7)	2% (1)	45
I want to help people by providing treatment on an individual basis*	Dental	100% (17)	0	0	17
	Academic	52% (24)	28% (13)	20% (9)	46
I want to help people by becoming involved in educating future generations of dental professionals*	Dental	71% (12)	24% (4)	5% (1)	17
	Academic	96% (44)	4% (2)	0	46
I want to help people by being involved in policy changes that affect society*	Dental	35% (6)	65% (11)	0	17
	Academic	74% (34)	24% (11)	2% (1)	46
<b>Work environment or position envisioned when selecting field of study included:</b>					
Regular hours*	Dental	67% (10)	13% (2)	20% (3)	15
	Academic	13% (7)	45% (21)	37% (17)	46
Control of my own work environment	Dental	100% (15)	0	0	15
	Academic	67% (31)	28% (13)	5% (2)	46
Employment at an educational institution*	Dental	27% (4)	33% (5)	20% (6)	15
	Academic	85% (39)	15% (7)	0	46
An affluent lifestyle	Dental	24% (4)	47% (8)	29% (5)	17
	Academic	15% (7)	46% (21)	39% (18)	46
The ability to work independently	Dental	88% (15)	12% (2)	0	17
	Academic	72% (33)	20% (9)	8% (4)	46
Collaboration with peers	Dental	65% (11)	29% (5)	6% (1)	17
	Academic	87% (40)	13% (6)	0	46

\*Statistically different responses between degree types ( $p<0.05$ ) based on logistic regression analysis, corresponding odds ratio presented in Table VI

40% of all respondents combined agreed that their dental hygiene instructors had been instrumental in motivating advanced education.

Motivation to pursue advanced education also varied according to degree type (Table III). All dental respondents agreed with being motivated to advance their clinical skills as a means to be involved in more challenging procedures. The dental respondents were also more likely than academic degree respondents to agree to statements of gaining a deeper understanding of the science supporting treatment of oral disease ( $p=0.04$ ) and a greater knowledge base of treatment options/therapies used to combat oral diseases ( $p=0.002$ ). In response to the "other" option, both groups of respondents provided the following additional reasons for advancing their education: increased knowledge, professional advancement, and financial motivation.

Influential persons and experiences leading to respondents' decisions to pursue doctoral degrees are described in Table IV. Compared to respondents with academic degrees, those with dental degrees were influenced to advance their education by a dentist/dental professional ( $p=0.01$ ) or a family member ( $p=0.04$ ). Academic respondents were influenced more by an educator ( $p=0.01$ ) and had more experience observing or working with a researcher and/or scientist than dental respondents ( $p=0.004$ ). Similar percentages of dental and academic degree

respondents indicated that their continued education was self-initiated (12.5% and 13.0%, respectively).

Seventy-one percent of dental degree respondents reported satisfaction working as a clinical dental hygienist compared to 42% of the academic respondents, although the difference was not statistically significant (Table V). Respondents from both groups who expressed a neutral opinion or dissatisfaction with clinical dental hygiene selected as many of the following reasons as were applicable to them: repetitive procedures, limited scope of practice, being treated subserviently, lack of promotional opportunities and other. The following themes were developed based on respondents (34%) who selected "other" reasons for dissatisfaction: perceived lack of respect, disappointment with the clinical environment, and lack of stimulation.

Due to the large number of survey items, Table VI lists only those items where the respondent group responses were significantly different. The highest odds ratio was for the survey item, "encouraged to earn degrees in dentistry," meaning that the dental respondents were 33 times more likely (95%, CI:8.3, 100.0,  $p<0.0001$ ) than the academic respondents to have been encouraged to earn degrees in dentistry. Conversely, the academic respondents were 15 times more likely (95%, CI:3.4, 67.0,  $p=0.0003$ ) to have selected the response, "encouraged to earn doctorate in a subject other than dentistry."

**Table III.** Encouraging and motivating factors for advancing education at the doctoral level

Factors	Degree	Agree % (n)	Neutral % (n)	Disagree % (n)	Total (n)
Encouraged to pursue a doctorate in a subject other than dentistry*	Dental	0	18% (3)	82% (14)	17
	Academic	71% (32)	20% (9)	8% (4)	45
Encouraged to pursue a doctorate in dentistry*	Dental	75% (12)	19% (3)	6% (1)	16
	Academic	14% (6)	29% (13)	57% (26)	45
Dental hygiene instructors were instrumental in motivating advanced education	Dental	52% (9)	24% (4)	24% (4)	17
	Academic	36% (16)	31% (14)	33% (15)	45
To advance clinical skill and be involved in more challenging procedures	Dental	100% (16)	0	0	16
	Academic	35% (16)	20% (9)	45% (20)	45
To gain deeper understanding of the science supporting treatment of oral diseases*	Dental	68% (11)	25% (4)	6% (1)	16
	Academic	40% (18)	38% (17)	22% (10)	45
To gain a greater knowledge base of treatment options/therapies used to combat oral diseases*	Dental	94% (15)	6% (1)	0	16
	Academic	42% (19)	36% (16)	22% (10)	45

\*Statistically different responses between degree types ( $p<0.05$ ) based on logistic regression analysis, corresponding odds ratio presented in Table VI

**Table IV.** Influential people and observation/work experiences of respondents

	Dental % (n)	Academic % (n)
<b>The most influential person who encouraged respondents to continue their education:</b>		
Educator*	12.5% (2)	43% (20)
Dentist/dental professional*	38% (6)	6% (3)
Researcher/scientist	0	9% (4)
Employer	6% (1)	2% (1)
Family member*	19% (3)	9% (4)
Spouse	6% (1)	9% (4)
Friend	6% (1)	9% (4)
Self-initiative	12.5% (2)	13% (6)
<b>Experience observing or working with the following before selecting doctoral degree type</b>		
Researcher*	50% (8)	82% (35)
Dentist	100% (17)	82% (35)
Educator	71% (12)	100%(46)

\*Statistically different responses between degree types ( $p < 0.05$ ) based on logistic regression analysis, corresponding odds ratio presented in Table VI

Themes were also developed based on the patterns of responses to the open-ended survey question regarding descriptions of experiences influencing respondents to pursue doctoral degrees. Forty-five out of the 63 respondents shared a motivating experience. Nearly half (49%) of those individuals described an experience focused on attaining personal professional advancement. Representative statements from academic degree respondents also included: "All full-time faculty at the university where I teach are required to hold a doctorate," "I wanted to earn one degree higher to be better qualified to teach graduate students, especially related to research," and "I was the only one without a doctoral degree. I was being overlooked for mid-level/senior administrative positions."

"Increased knowledge" was another theme exemplified by statements from 16% from both categories of respondents. Academic degree respondents expressed statements, such as "I wanted more education to hone research skills" and "Working in a laboratory conducting research was a great experience and convinced me that I wanted to spend my career constantly learning new things, rather than doing the same procedure over and over again." Dental degree respondents stated comments similar to: "Enjoyed clinical practice and wanted to help more people."

**Table V.** Satisfaction level of respondents with working as a clinical dental hygienist

	Degree	Satisfied % (n)	Neutral % (n)	Dissatisfied % (n)	Total (n)
Satisfaction with working as a clinical dental hygienist	Dental	71%(12)	12%(2)	18%(3)	17
	Academic	42%(19)	26%(12)	33%(15)	46
<b>*Lack of satisfaction with clinical dental hygiene was due to:</b>					
Repetitive procedures	Dental	80%(4)	20%(1)	0	5
	Academic	81%(22)	15%(4)	4% (1)	27
Limited scope of practice	Dental	100%(5)	0	0	5
	Academic	74%(20)	19%(5)	7% (1)	27
Being treated subserviently	Dental	80%(4)	0	20%(1)	5
	Academic	70%(19)	19%(5)	11%(3)	27
Lack of promotional opportunities	Dental	80%(4)	0	4% (1)	5
	Academic	78%(21)	19%(5)	4% (1)	27

\*Questions only answered by respondents who reported being neutral or dissatisfied

**Table VI.** Univariate association of survey items with type of doctoral degree

Survey Items*	Reference Group	Odds Ratio, [95% Confidence Intervals]	P-VALUE
Time spent working in clinical dental hygiene	Academic	4.3, [2.6,1116]	0.01
Mechanically inclined	Dental	4.3, [1.1,16.7]	0.03
Prefer to read current research studies than to learn a new skill	Academic	10.2, [3.0,34.0]	0.0002
Help people by involvement in policy changes	Academic	5.8, [1.9,17.9]	0.002
Help people by educating dental professionals	Academic	7.0, [1.2,40.0]	0.03
Envision employment at an educational institution	Academic	20.0, [5.4,77.0]	<0.0001
Desire regular hours	Dental	9.1, [2.8,33.3]	0.0003
Encouraged to earn degrees in dentistry	Dental	33.3, [8.3,100.0]	<0.0001
Encouraged to earn doctorate in a subject other than dentistry	Academic	15.0, [3.4,67.0]	0.0003
Motivated to gain a deeper understanding of science supporting treatment	Dental	3.2,[1.04,10.0]	0.042
Motivated to gain greater knowledge of treatment options/therapies	Dental	25, [3.3,100.0]	0.002
Influenced to advance education by a dentist/dental professional	Dental	9.9, [1.7,50.0]	0.01
Influenced to advance education by a family member	Dental	9.9, [1.1,50.0]	0.04
Influenced to advance education by an educator	Academic	9.9, [1.7,50.0]	0.01
Experience observing or working with a researcher and/or scientist	Academic	5.5, [1.7,17.7]	0.004

\* Survey items presented represent those with significant differences between groups. All odds ratios were calculated to be above one, and the reference group was changed accordingly.

Quotes from four respondents, relating to the theme of the advancement of the dental hygiene profession included: "...desire to raise the level of dental hygiene to doctoral and have more educators at this level" and "I want to make a difference in dental hygiene and I felt I needed to have a doctorate outside of dentistry to do that." The specific numbers of responses for each of the remaining themes were prior academic experience (4), family influence (3), financial motivation (2), peer/mentor influence (1), gaining respect (1), and personal experiences with dentistry (1).

## Discussion

### Interests and Characteristics of the Respondents

This study identified factors influencing dental hygienists to pursue doctoral education by comparing the responses of dental hygienists who had earned

dental degrees (DDS and DMD) to those with academic degrees (PhD, EdD, and others). As both groups of respondents began careers as dental hygienists, they identified a number of shared interests and characteristics, ones that may have initially attracted them to the profession, such as working one-on-one with people as being important for their career satisfaction.

The survey questions also identified several parameters that distinguished respondents with dental degrees from those with academic degrees. First, dental respondents in this study were more likely than academic respondents to consider themselves mechanically inclined, defined as preferring to solve problems and work on projects that require building or repairing things with one's hands. This interest confirms results of previous studies.<sup>1,10</sup> In the study of career motivators for dental students conducted by Du Toit et al., "I like working with my hands and

being artistic" was selected by respondents from 13 different countries.<sup>5</sup> Job satisfaction has been shown to be related to the opportunity to use one's abilities,<sup>11</sup> and study respondents may have been piqued to pursue a dental degree by a desire to use their artistic abilities.

Another distinguishing characteristic between the groups was the academic degree respondents' preference to read about current research rather than to learn a new skill. It is likely that these respondents were actively involved with reading and evaluating current research studies throughout their doctoral educational programs. Furthermore, these activities and skills are fundamental to both teaching at institutions of higher education and conducting scientific research. In contrast, results of a recent systematic literature review of information-seeking behaviors of dentists indicated that dentists tended to adopt new materials and techniques after discussion with a colleague, a dental specialist, or a respected dental expert, rather than studying evidence-based resources,<sup>12</sup> which is in agreement with the findings of this study.

A desire to help people was a common interest of both groups in this study; however, there were remarkable differences to the approaches to this common goal. Respondents with dental degrees were in unanimous agreement about helping people by providing care on an individual basis, as supported by employment positions in private practice (65%) and in community clinics (21%). In a study conducted by Scarbecz and Ross, the third top reason for pursuing a career in dentistry for both males and females was a desire to treat or help people to improve their appearance,<sup>1</sup> and is reflected in other study findings regarding the employment settings of dentists and the provision of treatment on an individual basis.<sup>13</sup>

In contrast, academic respondents indicated a desire to help people by becoming involved in the education of future generations of dental professionals, as indicated by the academic institution employment settings of 96% of respondents of this study. Motivations for a faculty career for both groups of respondents may be similar. Research conducted by Gibbs and Griffin reported a desire to serve as a role model and facilitate the success of students as being a key motivator in biomedical science education.<sup>7</sup> Although it was a smaller percentage when compared to the academic respondents, 43% of the dental respondents reported that they were also employed in academic positions. Intellectual challenge, research opportunities, and a desire to become a university administrator are factors identified in previous studies regarding dentists' career choices in academic dentistry.<sup>14</sup> Additionally, female dental specialists reported positive career and personal life balance found in academic dentistry.<sup>15</sup>

Helping people through involvement in policy decisions affecting society as a whole, was reported more frequently by academic respondents than dental respondents. Doctoral education may have helped prepare academic respondents to collaborate with other healthcare professionals in bringing changes through public policy.<sup>9</sup> Dental hygienists with academic doctoral degrees may be able to help create healthier communities by conducting research and developing policies related to oral disease prevention and health promotion, a proposed program goal for a doctoral degree in dental hygiene.<sup>9</sup>

Dental and academic respondents in this study envisioned certain aspects of their work environment in similar ways. Both groups anticipated an affluent lifestyle contrary to the expectations that a greater percentage of dental respondents would indicate income as being a motive for pursuing a dental career.<sup>1,3,4</sup> Dental respondents in this study may have had more realistic expectations as compared to previous research.<sup>1,3,4,11,16</sup> A major difference between the dental and academic respondents was that more dental respondents indicate regular work hours as a career preference mirroring previous studies.<sup>5,16</sup> Regular working hours was ranked eighth out of the top 30 reasons for pursuing dentistry by both males and females.<sup>1</sup>

Both groups in this study also agreed that they preferred an independent work environment; results which agree with previous studies of both dental and research-oriented students.<sup>1,6</sup> Dental respondents in this study also envisioned control of their work environment, supporting the findings of Chambers' review of job satisfaction in dentistry.<sup>16</sup> Chambers identified typical job satisfiers in dentistry as being factors under their control, such as what goes on in their office.<sup>16</sup> Other studies have identified specific aspects of control, including greater freedom and flexibility in scheduling their work.<sup>1</sup> In this study two-thirds of the academic respondents also envisioned control of their work environment. These respondents may have considered control of the work environment differently than dentists, possibly contemplating freedom to pursue research topics of interest<sup>7</sup> and being able to think or act independently with limited consultation or guidance from others,<sup>6</sup> as suggested by previous studies.

### **Influential Persons and Experiences; Encouraging and Motivating Factors**

Study respondents expressed receiving encouragement to pursue advanced education from various sources, only a small percentage reported internal motivation for earning their doctoral degree. Most had been encouraged to advance their education by a known individual. The importance of this key factor as a recruitment tool is evidenced by the statistically significant results that both the dental and academic

groups of respondents had been encouraged to pursue the doctoral degree that they subsequently earned. Dentists appeared to be very instrumental at guiding dental hygienists and pre-dental students<sup>4</sup> toward dental degrees. Approximately one-third of dental respondents in this study reported that a dentist or dental professional had been the most influential person in encouraging them to pursue a dental degree and that they had observed or worked with a dentist. These findings were supported by a study of pre-dental students demonstrating that more than half of the respondents identified their family dentist as the professional who most influenced their decision to pursue dentistry.<sup>4</sup> Another study of final-year British dental students indicated that work experiences and other encounters with dentists at work had been an important influence, particularly when the dentists appeared to find their work enjoyable or satisfying.<sup>3</sup>

While all of the respondents in this study had doctoral degrees, their parents had varying levels of education. This finding is of interest since parents have been shown to influence the level of education of their children,<sup>17,18</sup> regardless of their own academic achievements. Previous research has also shown that parents with advanced education may have set high aspiration and achievement standards for their children and served as academic or occupational role models.<sup>17</sup> Conversely, parents without college degrees may have impressed upon their child the importance of academic achievements and their relationship to upward mobility with respect to a career. Of the respondents with academic degrees in this study, fewer than 10% indicated that a family member played an influential role in encouraging their advanced education. These results are consistent McGee and Keller's research on doctoral students' opinions of individuals who played critical roles in guiding their interests and career directions; very spoke of parents or other family members, whereas many referred to teachers, research mentors, and other role models.<sup>6</sup>

Of the respondents with academic degrees in this study, 43% reported having been influenced by an educator. These respondents indicated their agreement utilizing a Likert scale with the following survey statements: an educator was the most influential person; they were encouraged to pursue a doctorate in a subject area other than dentistry; and they experienced working with or observing a researcher or scientist before starting a doctoral degree program. Taken together, these statements point to the underlying importance of mentoring potential candidates for academically based doctoral degrees.

### **Relationships with Dental Hygiene**

Respondents who had most recently graduated from entry-level dental hygiene programs were more likely to pursue a dental degree than an academic

degree reflecting a classically held view that dental hygiene could serve as an introduction or foundation for dentistry.<sup>19</sup> Dental degree respondents in this survey may have enjoyed the patient care aspect of dental hygiene, but felt dissatisfied or limited by the scope of practice or knowledge base. Data from this study indicate that the dental degree group may have been motivated to advance their clinical skills to gain a greater knowledge base of the options used to treat and prevent oral diseases.

A greater percentage of academic versus dental degree respondents expressed dissatisfaction while working clinically as a dental hygienist, prior to their doctoral education. Low satisfaction was reported to be due to the lack of promotional opportunities and being treated subserviently; findings similar to previous studies, reporting dissatisfaction in clinical practice due to the lack of financial and career growth opportunities, insufficient communication with the dentist, and long work hours.<sup>20,21</sup>

Dental hygiene educators carry the responsibility for teaching students the foundational knowledge and requisite clinical skills, however to advance the profession they also need to recognize the importance of mentoring. A mentor is defined as someone willing to share career experiences; a supporter who offers encouragement, provides performance specific feedback, and assists students to obtain opportunities.<sup>22,23</sup> Dental hygiene instructors as mentors could have a valuable influence on dental hygiene considering advanced degrees. Faculty role models have been shown to be pivotal in students career choices in research and academia.<sup>14,24</sup> An important finding in this study was that only 40% of all respondents agreed and 29% expressed being neutral regarding the role that their dental hygiene instructors had played in motivating their advanced education. Considering that the majority of entry-level dental hygienists graduate from certificate or associate degree programs, dental hygiene educators need to be aware of the importance of encouraging advanced education options. Pipeline programs and early outreach efforts in regards to academic careers have been shown to be effective recruitment strategies.<sup>25</sup>

Ongoing discussions on the value and benefits of advanced education during entry-level dental hygiene education may serve to encourage and motivate future graduate students.<sup>9</sup> Duties and career choices within dentistry are well known, especially to those with family members in the field. Dental hygienists exploring options for advanced education may choose dentistry based on its familiarity. Integrating dental hygiene-based research into classroom experiences that can be linked to more detailed descriptions of the different types of doctoral degrees and their applications can inspire students to think of multiple opportunities beyond clinical practice. Research conducted by Boyd and Bailey demonstrated



that one-third of their respondents were unclear regarding the opportunities and value of obtaining a graduate degree in dental hygiene and therefore were reluctant to pursue graduate education.<sup>26</sup>

Early exposures or encounters have been reported to influence thoughts on pursuing graduate education. Findings from Smith et al.'s research-doctorate pipeline initiative showed that students do not know where their interests lie unless they have been exposed to new opportunities.<sup>27</sup> Another study conducted with undergraduate nursing students identified as having no interest in research, showed that after engaging in meaningful research activities, students reported enhanced research interests, which subsequently influenced their future career plans.<sup>27</sup> Entry-level dental hygiene students could be introduced to the research process by teaching them skills in searching and evaluating the literature, requisite to adopting an evidence-based approach to patient care and graduate programs could create opportunities for dental hygiene master's degree students to participate in on-going studies, conducted by established researchers.<sup>28</sup> Increased numbers of dental hygienists with experience in the research process are needed to play this critical role in dental hygiene education and advancement of the profession. The development of a research-based doctoral degree program in dental hygiene would be advantageous to increase the number of dental hygienists with academic doctoral degrees to fulfill this role.<sup>9</sup>

### Limitations

The unequal number of respondents in the academic and dental doctoral groups limited the findings of this study. While the number of potential participants were similar for both groups, more dental hygienists with academic degrees responded to the survey. Respondents from the academic group may be actively involved in dental hygiene education and recognize the importance of doctoral education for the advancement of the profession, resulting in a response bias. A second limitation was that the survey items relating to motivating factors were more descriptive of the practice of dentistry than academic interests. Items including increased knowledge, professional advancement, and intellectual challenge, which are more related to academic career choices, could have been included. Also, responses to survey items regarding the most influential person may have been dependent upon the respondent's interpretation of the term educator, that was assumed to include a dental hygienist/instructor. Qualifying terms to differentiate educators as dentists from dental hygienists were lacking, as well as distinctions between dentist/dental professionals who may or may not have been educators. Considering that 25% of the dental respondents were also recent dental hygiene graduates, the 71% who selected observing or working with an educator may have

been referring to instructors in their dental hygiene educational programs, which would have included both dentists and dental hygienists. If the term educator had specified non-dentist, the percentage of dental respondents selecting educators may have been lower.

### Conclusions

Respondents with dental degrees reported differences from those with academic degrees in terms of the person(s) and experiences that were influential in encouraging and motivating them to pursue a doctoral degree. For dental degree respondents, other dentists and clinical experiences had been the most influential factors. Respondents with academic degrees reported experiences observing or working with a scientist/researcher and that an educator had been the most influential person in their career pathway. These specific types of career relationships emphasize the importance of influential persons and experiences in the career decision-making process. Opportunities exist for the dental hygiene community to actively assume an influential role for dental hygiene students, practitioners and faculty to consider academic doctoral education as a career path. Dental hygienists possessing characteristics similar to the academic degree respondents in this study should be encouraged to pursue academic doctoral education, providing the necessary skills to advance the dental hygiene profession.

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## Effectiveness of an Antigen-Specific *Streptococcus mutans* Chairside Test as Compared to a Culture-Based *S. mutans* Test

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### Abstract

**Purpose:** To compare the effectiveness of an antigen-specific *Streptococcus mutans* (*S. mutans*) chairside test to a culture based *S. mutans* test.

**Methods:** Fifty-three patients receiving dental hygiene care at the University of Missouri-Kansas City, School of Dentistry were enrolled in the study. Stimulated saliva was collected from the patients and utilized for both bacteria tests. The antigen-specific test was compared to the culture-based bacteria test and to a caries risk assessment measuring sensitivity and specificity.

**Results:** The majority of participants were male (53%) with high caries risk (60%). The culture based test results were primarily negative (62%); while the antigen-specific test had more positives (76%). The sensitivity and specificity comparing the antigen-specific test to the culture based test was high (88%, 95% CI = (78%, 97%)) and low (25%, 95% CI = (13%, 37%)), respectively. The sensitivity and specificity comparing the antigen-specific test to caries risk was high (83%, 95% CI = (72%, 93%)) and low (38%, 95% CI = (24%, 51%)) respectively.

**Conclusions:** While the sensitivity of the antigen-specific test was high for both the culture-based test and caries risk, the specificity was low for both. These results suggest that the antigen-specific test tends to give a higher proportion of false positive results.

**Keywords:** caries risk assessment, salivary testing, culture-based bacteria test, antigen-specific assay test

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### Introduction:

Dental caries is a multifactorial and infectious disease of microbial origin impacting every specialty within dentistry.<sup>1,2</sup> One factor in the etiology of dental caries is *mutans streptococci* (MS).<sup>2-4</sup> The *mutans streptococci* include the *Streptococcus mutans* and *Streptococcus sobrinus* species of bacteria. *Mutans streptococci* colonize the host only after the first teeth erupt<sup>5-7</sup> and can be passed to children simply by the transference of saliva.<sup>5, 8-10</sup>

*S. mutans* species are elevated in saliva of individuals who are susceptible to dental caries.<sup>11</sup> Chairside tests are available to assist in determining caries risk due to the presence or absence of *S. mutans* through the use of stimulated saliva.<sup>12, 13</sup> Chairside tests come in two categories: culture-based tests and antigen-specific assays. The culture-based *S. mutans* tests are conducted on collected saliva and are sensitive enough to provide a degree of low,

medium, or high cariogenic bacterial challenge.<sup>12, 13</sup> The most common culture-based medium to test for streptococci is the Mitis-Salivarius agar or Mitis Salivarius agar with bacitracin (MSB).<sup>12</sup> The agar is inoculated with stimulated saliva elicited by chewing on a small paraffin block to dislodge bacterial plaque while dispersing it into the saliva. Caries risk test, CRT<sup>®</sup> (Ivoclar Vivadent Inc, Amherst, NY), is a dental chairside test utilizing a blue Mitis-Salivarius agar with bacitracin to detect *mutans streptococcus* and a Rogosa agar to evaluate the presence of lactobacilli.<sup>14</sup> Comparisons of CRT<sup>®</sup> with standard microbial laboratory methods demonstrate similar results.<sup>15-17</sup> The same is true for comparison with a similar system, Dentocult<sup>®</sup> (Orion Diagnostica, Espoo, Finland), which had been considered to be the standard chairside caries risk testing procedure until the late nineteen-nineties.<sup>17</sup>

Another type of caries risk test is based on an antigen-specific assay. These tests utilize highly specific monoclonal antibodies which provide absolute specificity for the bacteria of choice. The rapid detection *S. mutans* dental chairside test, Saliva-Check Mutans (GC America; Alsip, IL), is considered to be an antigen-specific assay. The test uses a combination of three highly specific anti-*S. mutans* monoclonal antibodies to increase binding and reduce the detection limit for 100,000 bacterial colonies per mL of saliva, the recognized level for increased caries risk.<sup>12</sup> Unlike culture-based tests, viable bacteria are not needed for this type of testing.<sup>12</sup> The purpose of this study is to compare the effectiveness of an antigen-specific *Streptococcus mutans* (*S. mutans*) chairside test to a culture-based *S. mutans* test.

## Methods

This study was a cross-sectional clinical trial conducted at the University of Missouri-Kansas City, School of Dentistry, utilizing subjects who were patients of record, seeking care in the dental hygiene clinic. All patients voluntarily chose to participate in the University of Missouri-Kansas City, Institutional Review Board approved study. A consent script was read to each subject and verbal consent was obtained by the clinical research assistants. Fifty-three (n=53) subjects consented to participate in the study and the electronic patient records were utilized to gather information from the medical history and dental records for subject demographics and caries risk.

Normal standard of care procedures for patients presenting to the dental hygiene clinic includes the collection of saliva and determination of caries risk by using the Caries Management by Risk Assessment (CAMBRA) criteria<sup>3</sup> which is entered in the electronic patient record. The determination of caries risk is as follows: Low (no disease indicators, <2 risk factors, has protective factors), Moderate (no disease indicators, > 2 risk factors, but no caries), and High (cavitated lesion(s)/disease indicators or > 3 risk factors). For the purposes of this study, caries risk was evaluated without the *S. mutans* component.

Patients enrolled in the study were instructed not to smoke, eat, drink, brush their teeth or use a mouth rinse one hour prior to their appointment. The routine saliva collection process facilitated the determination of stimulated and unstimulated pH and the buffering capacity required for the caries risk assessment. The antigen-specific assay chairside test, Saliva-Check Mutans (GC America, Inc.; Alsip, IL) and the culture-based bacteria test, CRT® (Ivoclar Vivadent, Inc.; Amherst, NY), were administered during a routine appointment in the dental hygiene clinic as part of the participant's intra-oral examination. Clinical research assistants, calibrated on the manufacturer instructions for collection by the chief examiner,

collected the saliva and conducted the tests according to the manufacturers' specifications.

The clinical research assistants also collected and recorded the following information from the dental records into a password protected spreadsheet: caries risk, tobacco use status, current or recent use of antibiotic (within 2 weeks) and any use of an antimicrobial rinse. Bacteria tests conducted as part of the study were not factored into the caries risk determination, since bacteria tests can either be utilized as a baseline reference or for suspicion of high bacterial challenge.

The antigen-specific test for colony count of *mutans Streptococcus* levels was used in this study. The patient chewed on paraffin wax for one minute and then expectorated into a calibrated plastic medicine cup for a stimulated saliva sample. Stimulated saliva from the cup was poured into the saliva collection vessel provided in the antigen-specific test kit, up to the indicator line. One drop of reagent one (alkaline agent) was then added to the stimulated saliva and the container was tapped 15 times. Four drops of reagent two (neutralizing agent) were then added to the stimulated saliva and the container was shaken until the sample turned green, indicating that the solution had gone from alkaline to neutral pH. The manufacturer included pipette was used to draw saliva up from the container and three drops of the sample were dispensed into the window of the test device. After 15 minutes time, the test device was observed for a positive or negative test result for *S. mutans*. A positive reading (red line is shown on the test line) indicated *S. mutans* levels were > 500,000 cfu/ml and a negative reading (no line shown on the test line) indicated < 500,000 cfu/ml of *S. mutans*. An invalid test reading signified the test did not clearly indicate a positive or negative reading.

The same stimulated, unmodified saliva collected for the antigen-specific test was used for the culture-based test. During this test procedure, a sodium bicarbonate (NaHCO<sub>3</sub>) tablet was placed in the manufacturer supplied test vial and carbon dioxide (CO<sub>2</sub>) was released upon contact with moisture. The protective foil was then removed from the cultured-based test agars. Using the supplied pipette, both agars were then covered with saliva taking care not to scratch the culture media. The agar carrier was held slightly oblique to prevent the saliva from flowing off too quickly and to allow for thorough wetting of the surface. The agar carrier was immediately placed in the test vial, which was then tightly sealed according to the manufacturer's directions. The agar carriers were then labelled with date and time, and placed in an incubator (37°C /99°F) located in the oral biology lab at the institution for 48 hours. The culture-based *S. mutans* test comparison diagram was used to determine negative or positive results for *S. mutans*.

The antigen-specific test results were compared to the culture-based *S. mutans* test results and to the caries risk assessment obtained using CAMBRA criteria (excluding the *S. mutans* component) using sensitivity and specificity.

## Results

Fifty-three volunteer subjects enrolled in the study. The majority were male 53% (n=53), 60% had high caries risk, 79% were non-smokers, 100% had not used any antibiotics within the last 2 weeks, and 96% had not recently used an antibacterial mouth rinse (Table I). The culture-based *S. mutans* test results were primarily negative (62%), while the antigen-specific test had more positive results (76%). There was one invalid result antigen-specific test (Table I).

Overall, the sensitivity when comparing the antigen-specific test to the culture-based *S. mutans* test was high (88%, 95% CI=(78%, 97%). Comparisons of specificity of the antigen-specific test to the

culture-based test was low (25%, 95% CI= (13%, 37%). The sensitivity of the antigen-specific test compared to caries risk was high (83%, 95% CI= (72%, 93%) while the specificity for this same comparison was low (38%, 95% CI = (24%, 51%). Sensitivity and specificity comparing antigen-specific to culture-based test and to caries risk is shown in Table II.

## Discussion

*S. mutans* is a major contributor to the development of dental caries.<sup>13,18-20</sup> Chairside testing for *S. mutans* is one component of the caries risk assessment tool utilized by dental professionals to determine patients' caries risk level. The caries management by risk assessment tool (CAMBRA) assists clinicians in managing caries through preventive counseling or clinical interventions.<sup>3</sup> Patients who have one or more disease indicators (cavities present, interproximal enamel lesions on radiographs, white spot lesions on smooth surfaces, and restorations placed within the last 3 years) fall into the high-risk category for caries.<sup>3</sup> Bacterial testing is recommended for these patients to determine their colonization levels of specific bacteria. Patients recruited for this study had not been screened for disease indicators which would have recommended the use of a bacterial test to determine their caries risk levels. The culture-based test had not been factored into the determination of the patients' caries risk, which might have changed the caries risk reflected in their initial assessment. For the purposes of this study, caries risk was utilized to compare the antigen-specific *S. mutans* chairside test to the culture-based test. Therefore, the bacteria test results were not utilized to determine caries risk in order to protect from unnecessary influence in the outcomes of the study.

Contraindications for the culture-based test indicate that patients who had recently received antibiotics would need to wait for at least two weeks before completing the test and patients who had used an

**Table I.** Test results and covariates of interest by caries risk assessment.

	Caries Risk			Total (N = 53)
	Low (N = 8) N (%)	Moderate (N = 10) N (%)	High (N = 35) N (%)	
Culture Based <i>S. mutans</i> Results				
Negative	7 (87.5%)	7 (70.0%)	19 (54.3%)	33 (62.3%)
Positive	1 (12.5%)	3 (30.0%)	16 (45.7%)	20 (37.7%)
Antigen-Specific Results				
Negative	3 (37.5%)	3 (30.0%)	6 (17.1%)	12 (22.6%)
Positive	5 (62.5%)	7 (70.0%)	28 (80.0%)	40 (75.5%)
Test Invalid	0 (0%)	0 (0%)	1 (2.9%)	1 (1.9%)
Gender				
Female	5 (62.5%)	6 (60.0%)	14 (40.0%)	25 (47.2%)
Male	3 (37.5%)	4 (40.0%)	21 (60.0%)	28 (52.8%)
Smoker				
No	8 (100%)	9 (90.0%)	25 (71.4%)	42 (79.2%)
Yes	0 (0%)	1 (10.0%)	10 (28.6%)	11 (20.8%)
Any Antibiotic Use				
No	8 (100%)	10 (100%)	33 (94.3%)	51 (96.2%)
Yes	0 (0%)	0 (0%)	2 (5.7%)	2 (3.8%)
Any Antibiotic Use within 2 Weeks				
No	8 (100%)	10 (100%)	35 (100%)	53 (100%)
Yes	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Any Recent Use of Antibacterial Mouth Rinse				
No	8 (100%)	10 (100%)	33 (94.3%)	51 (96.2%)
Yes	0 (0%)	0 (0%)	2 (5.7%)	2 (3.8%)

**Table II.** Sensitivity and specificity comparing antigen-specific to culture-based test and to caries risk (low vs. moderate or high)<sup>1</sup>

<b>Culture Based <i>S. Mutans</i> Test</b>						
	<b>Negative (N = 33) N (%)</b>	<b>Positive (N = 16) N (%)</b>	<b>Sensitivity*</b>	<b>95% CI</b>	<b>Specificity*</b>	<b>95% CI</b>
Antigen-Specific Test			87.50%	(78.14%, 96.86%)	25.00%	(12.75%, 37.25%)
Negative	8 (24.2%)	2 (12.5%)				
Positive	24 (72.7%)	14 (87.5%)				
Test Invalid	1 (3.0%)	0 (0%)				
<b>Caries Risk</b>						
	<b>Low (N = 8) N (%)</b>	<b>Moderate/ High (N = 41) N (%)</b>	<b>Sensitivity*</b>	<b>95% CI</b>	<b>Specificity*</b>	<b>95% CI</b>
Antigen-Specific Test			82.5%	(71.75%, 93.25%)	37.5%	(23.8%, 51.2%)
Negative	3 (37.5%)	7 (17.1%)				
Positive	5 (62.5%)	33 (80.5%)				
Test Invalid	0 (0%)	1 (2.4%)				

<sup>1</sup> Excluding patients with any antibiotic or any recent antibacterial mouth rinse use (n = 49)

\*Note: Sensitivity and Specificity calculations do not count the test invalid categories

antibacterial mouth rinse would need to wait at least twelve hours before culture-based testing could be performed. Antibiotic and antibacterial use can alter the effectiveness of the culture-based testing due to the associated reduction in the number of bacterial colonies. The study data indicated that 2% (n=2) of the patients had a history of antibiotic use, but none within 2 weeks. The data also indicated 2% (n=2) had recent used an antibacterial mouth rinse. Therefore, the analysis excluded these four subjects from the sensitivity and specificity calculations.

Precautions for the antigen-specific test indicate that patients are to be instructed not to smoke, consume food or drink, nor brush their teeth one hour prior to their appointment. Contraindications for both the culture-based test and the antigen specific-test may have altered the results. All subjects were instructed by the clinician to adhere to the same precautions as indicated for the routinely conducted

salivary testing which mirrored the precautions for the antigen-specific test. However, the researchers needed to rely on the subject's word regarding adherence to the precautions. Future studies should require that the subject report to the clinic setting one hour prior to the salivary testing to ensure compliance to the required precautions.

Caries risk is correlated to the levels of MS on the teeth.<sup>18</sup> The MS level detection limit is 100,000 /mL of colony forming units (cfu), the recognized level for increased caries risk.<sup>17,21</sup> The antigen-specific chairside test indicated a positive result with bacteria counts at 500,000 cfu/ml while the culture-based test detected MS 100,000 cfu/mL or  $\geq 10^5$  cfu.<sup>12,17</sup> At these levels, for the antigen-specific test to result in a positive indication for high levels of *S. mutans*, a level of 500,000 cfu would be necessary, whereas the culture-based test recognizes the *S. mutans* risk at 100,000 cfu. These limits are noteworthy since MS

level detection is recognized to increase at 100,000 cfu/mL or  $\geq 10^5$  cfu.

When comparing the antigen-specific test values with the culture-based *S. mutans* test and the MS threshold levels of detection, the following scenarios must be considered:

- If the antigen-specific test results in a positive (high risk) and the culture-based *S. mutans* test read positive (high risk), it indicates that the MS concentration has reached 500,000 cfu.
- If the antigen-specific test results in a negative (low risk) and culture-based *S. mutans* test reads positive (high risk), it indicates that the MS concentration has reached 100,000 cfu.
- If the antigen-specific test results in a negative (low risk) and culture-based *S. mutans* test reads negative (low risk), it indicates that the MS concentration was less than 100,000 cfu.
- If the antigen specific test does not read either negative (low risk) or positive (high risk) and the culture based *S. mutans* test is positive (high risk) or negative (low risk), it indicates that the antigen-specific test is not reliable for reading (missing data point).
- If the antigen-specific test reads positive (high risk) and culture-based *S. mutans* test reads negative (low risk), a concern is raised considering whether the culture-based *S. mutans* test is the more sensitive test. Further testing ensuring that the contraindications for the culture-based *S. mutans* test were not the factor would be needed, as those can confound the results of the test.

The culture-based *S. mutans* test was utilized in this study due to its proven reliability.<sup>16,17,22</sup> When comparing the two tests, one must take into consideration that the antigen-specific test is a newer product on the market, utilizing highly specific anti-*S. mutans* monoclonal antibodies designed to increase binding and reduce the detection limit.<sup>12</sup> The saliva sample collected for the antigen-specific test reacts with buffers to establish a constant pH and detergents for proper dispersal of the sample. The saliva sample is placed on a nitrocellulose strip with impregnated monoclonal antibodies which trap the *S. mutans* bacteria, triggering a detection reaction. Control reactants are utilized to ensure proper functioning of the detection chemistry.<sup>12</sup>

Dental offices should consider factors such as cost, time, reliability, and effectiveness when considering a chairside test for MS bacteria counts. The culture-based *S. mutans* test utilizes viable bacteria requiring incubation for 48 hours at 37°C; counter top incubators are available for dental practices to purchase. The antigen-specific test contains monoclonal antibodies to detect select *S.*

*mutans* species and can be completed chairside in five minutes, enabling the clinician to share the test results with the patient before the end of the appointment. The instant results of the antigen-specific assay provide clinicians with a rapid, valid test for the quantification of *mutans streptococci*. However, data from this study reveal that the antigen-specific test tends to yield a higher proportion of false positive results.

## Conclusion

While the sensitivity of the antigen-specific test was high for both the culture-based test and caries risk, the specificity was low for both types of tests. These results suggest that the antigen specific test tends to yield a higher proportion of false positive results.

## Disclosures

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# RESEARCH

## Reduced Depth Technique with the Posterior Superior Alveolar Block

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### Abstract

**Purpose:** The posterior superior alveolar (PSA) block is one of many techniques used to provide profound anesthesia for invasive dental procedures. This technique has a long history, with a high success rate, but is not without complication risks. The purpose of this study was to determine if pulpal anesthesia of the maxillary second molar could be achieved using a posterior superior alveolar block with a reduced depth of penetration of 10 mm compared to the current suggested depth of 16 mm.

**Methods:** Using a cold refrigerant, a thermal test was conducted using the buccal surface of a maxillary second molar of 43 participants. Positive neural responses were obtained from 100% of the participants (n=43) during the pretest. Each participant received a posterior superior alveolar block using a short (20mm), 27-gauge needle with the penetration depth reduced to 10mm. Post-test neural responses of these molars were evaluated using same cold thermal test technique.

**Results:** Study results demonstrated that the reduced depth technique for the PSA block was successful in 88% (n=38) of the participants; pulpal anesthesia of the maxillary second molar had been achieved. Furthermore, there were zero positive aspirations and zero hematomas observed in the participants.

**Conclusion:** The reduced needle depth technique showed promise in achieving desired results of pulpal anesthesia coupled with decreasing risk and complications associated with the PSA block. Additional blinded, randomized clinical studies are recommended to achieve evidence-based support for this reduced depth PSA block technique.

**Keywords:** local anesthesia, nerve blocks, pulpal anesthesia, clinical education

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### Introduction

The use of local anesthesia is essential to facilitate many procedures in the dental field. There are a variety of target sites and techniques used to achieve patient comfort. The posterior superior alveolar (PSA) block is used to achieve pulpal and soft tissue anesthesia to the maxillary third molars, second molars, as well as the first molars, with the exception of the mesiobuccal root in some cases.<sup>1-3</sup> When the middle superior alveolar (MSA) nerve is not present, as is the case with approximately 72% of the general population, the PSA nerve innervates the mesiobuccal root of the maxillary first molar and a PSA block will provide complete pulpal and soft tissue anesthesia here as well.<sup>1-4</sup> The PSA nerve is the target area for the PSA block injection, which requires access via the height of the mucobuccal fold just distal to the apex of the maxillary second molar. The current recommended technique for accessing the PSA nerve for an "average-sized" adult is a depth of 16mm.<sup>2,3</sup> There is allowance for the modification

for "most smaller-skulled" patients to a penetrating depth of 10-14 mm.<sup>2</sup> Student dental professionals are taught and tested using this recommended practice in their professional programs and on national and clinical board licensing examinations.<sup>2,5</sup> This injection technique often evokes anxiety in some clinicians as there is no osseous contact alerting the clinician that the proper depth has been reached, thus over insertion is a possibility.<sup>4</sup> The pterygoid plexus of veins is located in this area and the inadvertent penetration of this plexus and/or nearby maxillary artery can result in unpleasant complications for the patient.

The PSA block has a 3.1% positive aspiration rate, the second highest in the oral cavity, second only to the inferior alveolar block.<sup>3</sup> The risk of causing a large hematoma often deters clinicians from utilizing this nerve block, while instead choosing a less suitable supraperiosteal injection, requiring multiple needle penetrations to the patient. A variety of PSA techniques have been explored, including a study by

Harn, SD et al. which reported seventeen variations to the PSA technique being utilized by practitioners.<sup>6</sup> One conservative insertion technique has been suggested in the literature in an attempt to minimize these risks.<sup>2,7</sup> Given the depth of the target area of the PSA nerve as it exits the posterior superior alveolar foramina within the infratemporal fossa, it has been theorized that a shorter needle depth is sufficient for adequate anesthetic delivery while being far enough away from the pterygoid plexus of veins and maxillary artery to avoid puncture and hematoma risk.<sup>2,4</sup>

Minimal literature exists however, to validate efficacy and hematoma risk reductions while delivering a PSA block with a reduced needle depth insertion technique. The purpose of this study was to determine if pulpal anesthesia of the maxillary second molar could be achieved using a PSA block with a reduced depth of penetration of 10 mm as compared to the standard suggested depth of 16 mm while minimizing complication risks.

## Materials

This pilot study used a quasi-experimental design in which a single pre-test measurement (O1) was taken followed by an intervention (X) and finishing with a post-test measurement (O2).<sup>8</sup> Investigators assessed whether a reduction in needle depth of the PSA block resulted in achieving pulpal anesthesia of the maxillary second molar. Since only approximately 28% of the population has an MSA nerve to innervate the mesiobuccal root of the maxillary first molar, the second molar was selected as the test tooth to be studied.<sup>1-4</sup> Approval for this study was granted through the University of New Mexico's Institutional Review Board and the Human Research Protection Office (HRPO). Students enrolled in the undergraduate and graduate dental hygiene programs were recruited to participate. Informed consent was obtained from all participants and preliminary screening for eligibility was completed. The screening process included a review of health history, vital signs, and intraoral screening. Any participants indicating an allergy to lidocaine, blood clotting conditions, pregnant, or those taking anticoagulant medications or any type of analgesic within the last 12 hours were excluded from further participation in the study.

The intraoral screening was performed to evaluate teeth #2 and #15 to ensure they met the study criteria. Participants were immediately excluded from the study if they were missing both maxillary second molars. Each molar was assessed individually for any confounding features. Any maxillary second molar which had an amalgam, composite, crown or bridge, a root canal, an implant, frank decay or visible signs of active infection including an abscess or fistula in the maxillary molar area was not used in the study. Participants satisfying all criteria of the screening had a digital periapical radiograph of the qualified

tooth taken as a final evaluation to confirm there were no radiolucent areas or visible abnormalities.

A baseline neural response was obtained using a thermal test by applying a large cotton pellet with a refrigerant, 1,1,1,2 Tetrafluoroethane (Endo-ice®, Coltène/Whaledent Inc; Cuyahoga Falls, Ohio), to the middle third of the buccal surface of the tested tooth. Investigators noted either a positive or negative response to the test. After confirmation of positive response, a cotton tip applicator with 5% lidocaine topical anesthetic ointment was applied to the site of tissue penetration for 2 minutes. Participants were asked to close their mouth slightly, and shift their mandible towards the test side. They received the reduced depth PSA block using a 27-gauged, 20 mm short needle, angled 45 degrees posteriorly, 45 degrees superiorly and 45 degrees medially to the point of insertion. The needle was inserted at the height of the mucobuccal fold slightly distal to the second maxillary molar and advanced to a depth of 10mm. All PSA blocks were completed either by the investigator or co-investigator. The left-handed investigator completed the PSA blocks used to test tooth #15, and was observed by the co-investigator. PSA blocks used to test tooth #2 were completed by the right-handed co-investigator and were observed by the left-handed investigator. Both investigators were present for each injection to ensure proper technique with the reduced needle depth for the PSA block was achieved.

Once it was agreed upon by the investigator/observer that the depth of 10mm had been reached at the proper angle, the investigator/operator aspirated in two planes and administered one full cartridge (~1.8 mL) of lidocaine 2% with 1:100,000 epinephrine. At 10 minutes, the thermal test was conducted again to assess the neural response of the test tooth. The same refrigerant and technique previously described was used. Investigators noted either a positive or negative response to the test for each subject with a negative response indicating pulpal anesthesia had been achieved.

## Results

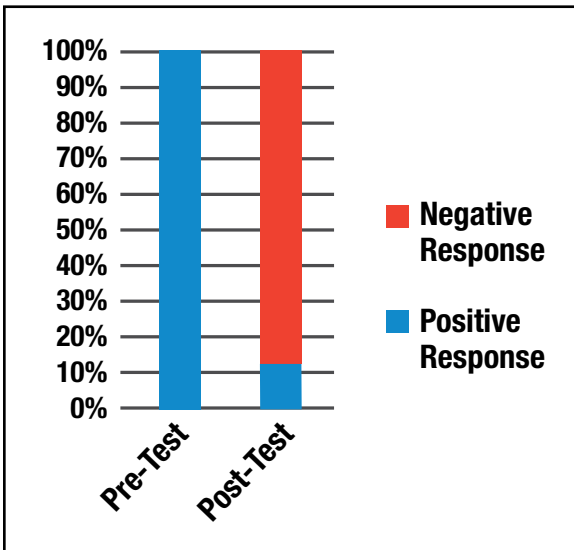
A total of 49 participants completed consent and enrolled in the pilot study however, after completing the screening process 6 participants were excluded as they either failed to satisfy minimum tooth requirements on tooth #2 or #15 or did not meet health history requirements. A total of 43 subjects, 39 females and 4 males, were eligible and participated in the study.

The pretest yielded a one hundred percent (n=43) "positive" baseline neural response when exposed to the refrigerant. Post-test results revealed an 88% (n=38) negative response, indicating no neural response was felt and pulpal anesthesia had been achieved on the majority of participants. This compared to 12% (n=5) of participants who still

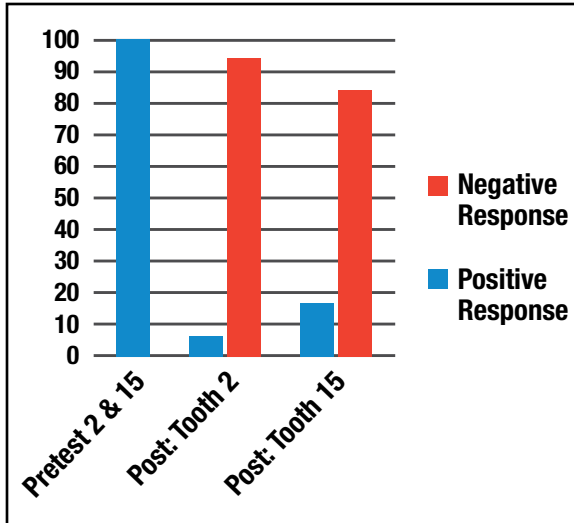
indicated a positive response on the post-test and did not achieve pulpal anesthesia. Figure 1 illustrates pre-test and post-test results of neural response of the tested teeth.

Investigators evaluated the injections administered to tooth #2 and tooth #15 individually. Twenty subjects received the modified PSA injection on tooth #2 and twenty-three subjects received it on tooth #15, resulting in

**Figure 1.** Pre-test and Post-test Results



**Figure 2.** Results for teeth #2 and #15



**Table I.** Pulpal anesthesia achieved with reduced depth PSA technique for individual tooth

Tooth Number	Number of injections	Pulpal anesthesia achieved using modified PSA	Pulpal anesthesia not achieved
2	20	19 (95%)	1 (5%)
15	23	19 (83%)	4 (17%)

a 95% and 83% negative neural response to the post-thermal test, respectively. Table I and Figure 2 illustrate the results for teeth #2 and #15 individually.

A Fisher's Exact test was performed against the null hypothesis statement that there was no difference between the two groups. The test revealed ( $p=0.219$  and  $\alpha$ -value of 0.05 ) that the null hypothesis could not be rejected. A Chi-squared test was also performed and confirmed previous findings. No positive aspirations or hematoma were observed as a result of the procedure.

## Discussion

Historically, it has been taught that in order to achieve profound anesthesia, the proper depth of penetration for the PSA block is 16mm.<sup>2, 3</sup> This depth of penetration is widely accepted among clinicians and educators, and is considered the measurable standard on local anesthesia clinical board examinations providing the rationale that a control was unnecessary for the purposes of this pilot study.

The traditional PSA block has a success rate of 95%.<sup>3</sup>

Complications of the PSA block are well documented in the literature and may range from local minor irritation at the injection site, trismus, or hematoma to more severe complications such as paresthesia and potential permanent eye complications.<sup>2, 3, 8-15</sup> This pilot study yielded an overall success rate of 88% in achieving pulpal anesthesia on the second molar, using the reduced depth technique. Additional successes of the study included no positive aspirations and no hematomas. Results of this study indicate that more conservative injection techniques could be explored to decrease the complication risks. Perhaps clinicians would then be less fearful of causing unsightly hematomas and utilize this effective nerve block to achieve profound anesthesia.

As hypothesized, the majority of participants achieved full pulpal anesthesia with the modified technique, however lack of randomization and the convenience sample used limits the generalizability of these results to a larger population. It is also recognized that the majority of participants were women, and while still considered to have an "average" size skull, it is accepted that women generally have a smaller skull size.<sup>2-4</sup> This could lead clinicians to think that the success rate of the reduced depth technique was influenced; however, investigators believe that results from this study provide support of the effectiveness of anesthesia through a PSA block at a reduced needle depth.

Dental practitioners routinely perform procedures such as periodontal probing, scaling and administering local anesthesia on both left and right sides of the mouth regardless of their dominant hand. In this pilot study, right- and left-handed investigators administered the PSA injection on their dominant

side for purposes of providing the best viewing conditions of the needle position and depth. A study conducted by Khan et al. concluded that there was no difference in periodontal assessments based on the clinician's "handedness"<sup>16</sup> and investigators believe the study results would have been replicated if only one investigator administered the injections on both sides of the mouth.

The limitations of a quasi-experimental pilot study are acknowledged. However, this quasi-experimental design was chosen intentionally for this pilot study to determine the logistical feasibility of conducting a larger randomized, blinded clinical study.

## Conclusion

The reduced needle depth technique showed promise in achieving desired results of pulpal anesthesia coupled with decreasing risk and complications. Additional randomized, controlled, blinded clinical studies are recommended to achieve evidence-based support for the academic and dental communities to assess replacing the current recommended PSA block technique with the modified PSA block with a reduced needle depth.

## Disclosure

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