

ABSTRACT

Title of Dissertation: NATIONAL SURVEY OF FOURTH-YEAR DENTAL STUDENTS ABOUT THEIR KNOWLEDGE, SKILLS, SELF-EFFICACY AND INTENTION TO USE SELECTED COMMUNICATION TECHNIQUES AND CARIES PREVENTIVE REGIMENS

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Background: Most dental school curricula do not emphasize communication skills and dental caries (tooth decay) prevention. Dentists play a vital role in educating patients about how to maintain good oral health. Thus, they must have knowledge of evidence-based regimens to prevent and manage oral diseases such as dental caries and they must be able to communicate this information to all their patients at a level the patient understands. Clear and effective communication is critical to delivering quality dental care to all patients, especially those who have low health literacy. There is limited information about how dental schools teach the communications skills and caries prevention competencies.

Methods: This 2018 national study used a 34-item online survey to assess fourth-year dental students' behavioral capability, self-efficacy and behavioral intention related to seventeen communication techniques and three caries preventive regimens – fluoride varnish, dental sealants and silver diamine fluoride. The survey link was emailed to 6,061 students. Statistical analyses included descriptive statistics, analysis of variance and logistic regression. The level of significance was set at $p < 0.05$ for all analyses. This study was exempt from review by the University of Maryland Institutional Review Board.

Results: The response rate was 4.0 percent ($n=242$). Eighty-six percent of students indicated they had received communication skills education and training in their dental program; 21.9 percent reported having a communications course in dental school; and ninety-seven percent reported education and training related to the three caries preventive regimens. Students who reported higher self-efficacy were 9.2 times as likely to report higher behavioral intention to use the communication techniques than those who reported lower self-efficacy, $p < .01$. For the caries preventive regimens, students who reported higher self-efficacy were 21.3 times as likely to report higher behavioral intention than those who reported lower self-efficacy, $p < .01$.

Conclusion: Dental schools have a responsibility to educate and train students about evidence-based caries preventive regimens and how to effectively communicate with patients. Our findings suggest some students need additional education and training related to the communication techniques and use of silver diamine fluoride. Findings from this assessment can help inform curricula development, implementation and content for board examinations.

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REGIMENS

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Dedication

This dissertation is in honor of my parents who believed in the power of education to
change lives.

I am eternally grateful to Dr. Alice M. Horowitz for her continual mentoring,
encouragement, insights and friendship every step of the way.

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List of Abbreviations

AAPD	American Academy of Pediatric Dentistry
ADA	American Dental Association
ADA CAAP	American Dental Association Council on Advocacy for Access and Prevention
ADA CSA	ADA Council on Scientific Affairs
ADA HPI	American Dental Association Health Policy Institute
ADA NACHLD	American Dental Association National Advisory Committee on Health Literacy in Dentistry (NACHLD)
ADEA	American Dental Education Association
ASDA	American Student Dental Association
CODA	Commission on Dental Accreditation
CPSTF	Community Preventive Services Task Force
D4	Fourth-year Dental Students
FDA	Food and Drug Administration
IOM	Institute of Medicine
NACHLD	National Advisory Committee on Health Literacy in Dentistry
SCT	Social Cognitive Theory
TPB	Theory of Planned Behavior
USPSTF	United States Preventive Services Task Force

Chapter 1: Overview of Study

Section 1.1: Background

Effective communication is a key component of patient-centered care. Strong communication skills allow a provider to ask questions, listen, respond to patient concerns, demonstrate empathy, and provide health information and guidance at a level the patient can understand.⁷⁰ Effective provider communication skills are critical to serving an increasingly diverse patient population with individuals from different cultural and socioeconomic backgrounds; differing exposure and experiences with the U.S. health care system; and varying levels of education and health literacy.^{1,71} Health literacy is influenced by both health system and individual level factors, and often there is a mismatch between the demands of the health care system and the skills and abilities of patients.¹ Health care providers can decrease demands the health care system places on individuals by using communication techniques designed to increase patient understanding.¹

We are interested in dentists' oral health knowledge and practices related to dental caries (tooth decay) prevention as well as their ability to communicate this information to their patients for three reasons. First, dentists are part of the health care delivery system and they play a vital role in educating patients and dental practice team members about best practices to obtain and maintain good oral health. Dentists' knowledge is amplified because they interact with many individuals, families, members of the community and other health care professionals. Many adults report their dentist is their primary source for oral health information, which places them in

a position to counter oral health myths and misinformation.^{15,16} Second, when dentists engage with patients and communicate health information in a manner their patients understand, these actions have the potential to increase patient involvement in self-care, increase patient oral health literacy and improve oral health outcomes.^{17–20} Third, when dentists use evidence-based caries preventive regimens such as fluoride varnish, pit and fissure dental sealants and silver diamine fluoride they can help decrease dental caries and improve patient oral health status.^{21–25} Improving the oral health literacy and oral health status of all patients can ultimately lead to a decrease in oral health disparities.

The American Dental Association (ADA) recognized low health literacy as a potential barrier to the prevention, diagnosis and treatment of oral diseases and in 2006 adopted resolutions to “encourage the development of undergraduate, graduate and continuing education programs to train dentists and allied dental team members to effectively communicate with patients with limited literacy skills.”^{26,27} In 2009, the Commission on Dental Accreditation (CODA) introduced competencies for graduating dentists that included communication/interpersonal skills because “clear, accurate and effective communication is an essential skill for dental practice”.^{28(p454)} Effective provider-patient communication is critical to patient care because it can reduce barriers patients face in understanding and using complex health information and all patients, especially those with low health literacy, benefit from less complex health information.^{1,29}

Reducing the complexity of health information is necessary because almost half of U.S. adults – 90 million people – have a below basic or basic level of health

literacy.³⁰ Low oral health literacy is a public health concern because good oral health is dependent upon individuals having accurate knowledge, understanding and skills to engage in appropriate self-care and professional care.³¹ Those with low oral health literacy are more likely to have lower levels of oral health knowledge, less likely to engage in oral health promoting behaviors, and more likely to have poorer oral health status than individuals with adequate oral health literacy.^{13,14,32–38} Effective dentist-patient communication can increase patient health literacy by helping patients understand health information, health conditions, treatment options and behaviors that promote health and prevent disease.^{1,3,39}

In addition to good communication skills, dentists must understand and use evidence-based approaches to prevent oral diseases such as dental caries. The current evidence-based guidance to prevent and manage dental caries emphasizes individualized risk assessment and care plans to prevent disease; accurate and early detection of caries lesions; and remineralization of non-cavitated lesions to prevent existing lesions from advancing and minimize surgical intervention.^{40–43} This conservative approach has been shown to reduce dental caries in children and adults.^{41–44} Despite the evidence supporting a conservative treatment of dental caries, most U.S. dental school curricula and student evaluations do not emphasize this approach.⁴⁵

There is limited information about the approaches dental schools have taken to incorporate the communications/interpersonal skills competency into their curricula, but recent studies found a lack of standardized practices in teaching and evaluating communication skills compared with other technical dental skills.^{19,46–57}

Furthermore, there is limited information about the approaches dental schools use to educate and train dental students about caries prevention. Thus, the National Advisory Committee on Health Literacy in Dentistry (NACHLD), ADA Council on Advocacy for Access and Prevention (CAAP) conducted a national survey of fourth-year dental (D4) students. The survey assessed students related to what is being taught in U.S. dental schools relating to seventeen communication techniques shown to improve patient understanding and three regimens that prevent dental caries – fluoride varnish, dental sealants and silver diamine fluoride. We selected these three regimens because fluorides and dental sealants play a pivotal role in preventing dental caries, and silver diamine fluoride arrests dental caries and reduces the need to perform restorative procedures in hospitals under general anesthesia for children.^{23–25,41} The CAAP approved the study and the ADA Health Policy Institute administered the survey. We assisted with questionnaire design and analyzed the data.

We evaluated six hypotheses – three related to the communication techniques and three related to the three caries preventive regimens.

- **Hypothesis 1.1:** Dental students who report greater behavioral capability report greater self-efficacy to use the communication techniques with patients compared to dental students who report lower behavioral capability.
- **Hypothesis 1.2:** Dental students who report greater self-efficacy report greater behavioral intention to use the communication techniques with their patients after graduation compared to dental students who report lower self-efficacy.
- **Hypothesis 1.3:** Dental students who report greater behavioral capability report greater behavioral intention to use the communication techniques with patients

after graduation compared to dental students who report lower behavioral capability.

- **Hypothesis 2.1:** Dental students who report greater behavioral capability report greater self-efficacy to use the caries preventive regimens with patients compared to dental students who report lower behavioral capability.
- **Hypothesis 2.2:** Dental students who report greater self-efficacy report greater behavioral intention to use the caries preventive regimens with their patients after graduation compared to dental students who report lower self-efficacy.

Hypothesis 2.3: Dental students who report greater behavioral capability report greater behavioral intention to use the caries preventive regimens with patients after graduation compared to dental students who report lower behavioral capability.

Section 1.2: Methods

To ground our research in behavioral theory, study measures were based on two Social Cognitive Theory (SCT) constructs and one Theory of Planned Behavior (TPB) construct.^{58,59} The SCT constructs are Behavioral Capability and Self-Efficacy. In this study, behavioral capability is the knowledge of and skills to use seventeen communication techniques and three caries preventive regimens; and self-efficacy is the confidence to use these communication techniques and caries preventive regimens. The TPB construct, Behavioral Intention, indicates the likelihood of performing a behavior, which in this study is using the communication techniques and caries preventive regimens with patients after graduation.⁶⁰ We used our conceptual model to examine the relationships between the behavioral capability,

self-efficacy and behavioral intention constructs. Our model predicted that higher reported levels of behavioral capability predicted higher reported levels of self-efficacy and behavioral intention, and higher reported levels of self-efficacy predicted higher reported levels of behavioral intention. We chose these constructs because previous research demonstrates their predictive validity (Bandura 86, 77 & FB 75).

We developed a 34-item survey instrument to assess students' knowledge/understanding, skills, self-efficacy and behavioral intention related to seventeen communication techniques and three caries preventive regimens. The survey was adapted from a national survey of general dentists that assessed routine use of communication techniques shown to promote patient understanding⁶¹ and studies of Maryland health care providers' use of communication techniques and caries preventive regimens.⁶²⁻⁶⁵ The survey was conducted between July and September 2018. Statistical analyses included descriptive statistics (frequencies and percentages), Pearson's chi-square test, Analysis of Variance (ANOVA) and logistic regression. The level of significance was set at $p < 0.05$ for all analyses. This research was exempt from review by the University of Maryland Institutional Review Board.

Section 1.3: Results

The survey link was sent to 6,061 students; 242 submitted it for a response rate of 4.0 percent. The majority of students attended a private dental school (59.5%), were female (61.2%), white (61.6%), born in the United States (73.1%), and had heard of health literacy or oral health literacy (91.7%). Compared to their 2015-2016 program cohort, respondents differed significantly in that they more likely be female (61.2% vs 48.8%, $p < .01$), white (61.6% vs. 54.4%, $p = .03$) and attend a private dental

school (59.5% vs. 48.7%, $p < .01$).⁶⁶ They differed from the 2019 graduating class in that slightly fewer planned to enter private practice (48.0% vs. 42.6%) and more than twice as many planned to practice at a Federally Qualified Health Center (FQHC) (3.5% vs. 8.7%).⁶⁷

Students were asked about their education and training related to the seventeen communication techniques. Eighty-six percent responded they had received such training, but only 66.1 percent reported being evaluated on these techniques. Of the 59.0 percent who indicated they had ever taken a communications course, 21.9 percent reported taking a communications course in dental school and 26.0 percent reported having lectures on communications that were integrated within courses in the dental school curricula. With regard to having knowledge/understanding of each of the communication techniques, affirmative responses ranged from 98.3 to 55.8 percent; eight techniques had a response rate of ninety percent or higher. Affirmative responses for skills to use each of the communication techniques ranged from 96.3 to 59.9 percent; six techniques had a response of ninety percent or higher. For self-efficacy to use the communication techniques, responses of 'extremely confident' ranged from 79.8 to 52.9 percent; seven techniques had a response rate of seventy percent or higher. For the primary outcome measure behavioral intention, responses of 'extremely likely' ranged from 83.1 to 37.6 percent, with only five techniques having a response rate of seventy percent or higher. Results of the logistic regression analysis indicated students who reported higher behavioral capability were 5.5 times as likely to report higher self-efficacy than those who reported lower behavioral capability, 95% CI (3.10, 9.80), $p < .01$; those who reported higher self-efficacy were

9.2 times as likely to report higher behavioral intention than those who reported lower self-efficacy, 95% CI (4.10, 16.96), $p < .01$; and those who reported higher self-efficacy were 7.6 times as likely to report higher behavioral intention than those who reported lower self-efficacy, 95% CI (4.02, 14.55), $p < .01$.

With regard to their education and training related to the three caries preventive regimens, 97.1 percent responded they had received such training, 89.3 percent reported being evaluated on these regimens, and 70.7 percent reported being evaluated in both the classroom and clinic. Students reported having knowledge, skills, self-efficacy and behavioral intention related to fluoride varnish and dental sealants, but fewer students reported they were ‘extremely confident’ in their ability to apply silver diamine fluoride and ‘extremely likely’ to use silver diamine fluoride with patients after graduation. Logistic regression analysis found students who reported higher behavioral capability had 18.7 times the odds of reporting higher self-efficacy than those who reported lower behavioral capability, 95% CI (8.43, 41.57), $p < .01$; those who reported higher self-efficacy had 21.3 times the odds of reporting higher behavioral intention to use the caries preventive regimens, 95% CI (10.62, 42.92), $p < .01$; and those who reported higher self-efficacy were 17.5 times as likely to report higher behavioral intention than those who reported lower self-efficacy, 95% CI (8.03, 37.95), $p < .01$.

Section 1.4: Conclusions

This research contributes to the dental education research field by providing information about two important aspects of dental education – education and training related to communication skills and caries prevention and management. Dental

schools are critical to educating and training students about how to effectively communicate with patients. Schools also have a responsibility to educate and train students about evidence-based preventive regimens such as silver diamine fluoride. Our results indicate some students need additional education and training related to communication skills and silver diamine fluoride. Findings from this assessment can be used as a basis for examining how these two important aspects of dental practice are taught at individual dental schools and can help inform curricula development and board examinations. Schools might review their caries prevention curricula in light of the new competency-based cariology curriculum developed by the ADEA Section on Cariology to ensure graduating dentists are proficient in using evidence-based preventive regimens.

Section 1.5: Overview of the Dissertation

This dissertation is organized into five chapters and includes three appendices. It also includes a *Glossary* of all terms used in the dissertation and a *Bibliography* of all references for the dissertation. *Chapter 1 – Overview of the Research* provides a synopsis of the study including the background, methods, results, and conclusions.

Chapter 2 – Literature Review begins by defining patient-centered health care and describes the importance of health care provider communication skills to patient health and the provider-patient relationship. Second, we define health literacy and oral health literacy; identify populations most affected by low health literacy; summarize the impact of low health literacy on patient health; and discuss how effective provider communication skills and practices can reduce barriers to care for all patients. Third, we describe the need for communication skills training in dental

school; discuss the efforts of the Commission on Dental Accreditation to increase education and training related to communication skills; and high-light published research about the teaching and assessment of communication skills courses in dental school. Fourth, we outline the need for greater emphasis on teaching caries prevention in dental school; discuss the efforts of the American Dental Education Association and the Commission on Dental Accreditation to increase emphasis on caries prevention in dental education; describe dental caries and the role of fluoride in preventing this disease; summarize the incidence, prevalence and recent trends of dental caries in the United States; and provide an overview of the three caries preventive regimens assessed in this study and the evidence for their effectiveness. Fifth, we discuss the use of behavioral theory in medical and dental education; and provide a justification for selecting the theoretical constructs used in the study.

Chapter 3 is entitled Dental Students Reported Skills, Self-Efficacy and Intention to Use Selected Communication Techniques: A National Survey and presents findings related to the seventeen communication techniques. *Chapter 4 is entitled Dental Students Reported Skills, Self-Efficacy and Intention to Use Caries Preventive Regimens: A National Survey* and presents findings related to the three caries preventive regimens. *Chapter 5 – Discussion* provides an overview of study findings, limitations and implications for future research.

As for the Appendices, Appendix A: describes study methods, Appendix B has the survey instrument, and Appendix C has the IRB application and approval. The dissertation ends with the *Bibliography* and *Glossary*.

Chapter 2: Literature Review

This literature review is organized as follows into five sections. *Section 2.1 – Provider-Patient Communication* defines patient-centered health care and describes the importance of health care provider communication skills to patient health and the provider-patient relationship. *Section 2.2 – Health Literacy* defines health literacy and oral health literacy; identifies populations most affected by low health literacy; summarizes the impact of low health literacy on patient health; and discusses how good provider communication skills and practices can reduce barriers to care for all patients, especially those with low health literacy. *Section 2.3 – Communication Skills Training for Dental Students* describes the need for communication skills training in dental school; discusses the efforts of the American Dental Education Association and the Commission on Dental Accreditation to increase dental students' communication skills; and highlights published research about the teaching and assessment of communication skills courses in dental school. *Section 2.4 – Caries Prevention Training for Dental Students* discusses caries prevention education in U.S. dental schools; describes dental caries; describes the role of fluoride in preventing dental caries; summarizes the incidence, prevalence and recent trends of dental caries in the United States; and provides an overview of the three caries preventive regimens assessed in this study and the evidence for their effectiveness. Finally, *Section 2.5 – Theoretical Framework* discusses the use of behavioral theory in medical and dental education; and provides justification for selecting the theoretical constructs used in this study.

Section 2.1: Provider-Patient Communication

Section 2.1.1: Patient-Centered Health Communication

Healthy People 2010, our nation's health objectives, first identified health communication as a priority in 2000⁶⁸ and by doing so recognized the importance of health communication to disease prevention, health promotion and well-being.⁶⁹ Concurrently, a 2001 Institute of Medicine (IOM) report, *Crossing the Quality Chasm*, identified six areas of the U.S. health care system that needed improvement so all patients receive high-quality care.⁷⁰ One of these areas was patient-centered care, which is defined as “care that is respectful of and responsive to individual patient preferences, needs and values, and ensuring that patient values guide all clinical decisions”.^{70(p49)} Effective communication is a key component of patient-centered care because good communication skills allow a provider to ask questions, listen, respond to patient concerns, demonstrate empathy, and provide health information and guidance at a level the patient can understand.⁷⁰ Effective provider communication skills are critical to serving an increasingly diverse patient population with individuals from different cultural and socioeconomic backgrounds; differing exposure and experiences with the U.S. health care system; and varying levels of education and health literacy.^{1,71} Good communication skills also are necessary because the dental workforce is increasingly becoming more diverse and dentists must be able to communicate effectively with team members.⁷²

Section 2.1.2: Physician-Patient Communication

Physician-patient communication is recognized as a core clinical skill that impacts many aspects of care.⁷³ Research shows that good physician communication skills have many benefits. Good physician-patient communication is associated with more comprehensive medical histories, which supports accurate diagnosis of health conditions.^{73–76} It is correlated with better identification of patients' needs, values and expectations, which supports patient-centered care.^{73,77,78} Further, patients are more likely to comprehend and retain medical information when providers communicate effectively.^{75,79,80}

Patients who report good communication with their physician are more likely to be satisfied with their care.^{81–85} They are more likely to trust their physician and follow the physician's guidance.^{86,87} Patients are more likely to adhere to treatment plans^{74,88} and self-manage chronic conditions.^{78,81,89,90} There is evidence that good communication increases patient safety and improves clinical outcomes for many conditions including diabetes, hypertension and cancer.^{78,91–93} Good communication between physicians and patients also is associated with less patient anxiety^{94,95} and a decreased likelihood of malpractice suits.⁹⁶

Section 2.1.3: Dentist-Patient Communication

As in medicine, dentist-patient communication is recognized as a critical clinical skill that impacts many aspects of care. The evidence for dentist-patient communication is less extensive than for physician-patient communication.^{17,55,73,81} Nonetheless, it is associated with higher perceived levels of provider

competence,^{20,94,97} higher patient satisfaction^{17,98,99} regular dental care, improved adherence to treatment plans,^{18,50,100} higher levels of self-rated oral health, and higher levels of oral health literacy.³ Dental provider communication skills are associated with patient anxiety, with higher ratings of the dentist's communication abilities corresponding to lower levels of patient anxiety.^{17,95} It also is associated with reduced risk of malpractice claims.^{50,100} Importantly, good dental provider communication skills are associated with improved oral health outcomes.¹⁷ Additionally, effective communication skills have been shown to improve dentists' interviewing skills and their ability to gather patient information,¹⁰⁰ which improve their ability to tailor health information to patients' needs.¹⁸

It is important to note that there are dentistry specific issues that can affect communication. The patient is often limited in their ability to talk during dental exams or treatments, which can impede communication.⁷³ Also, dental fear causes people to delay or avoid dental visits. When these individuals see the dentist they often have more extensive problems that require more involved treatment, which can further increase fear and negatively affect communication.⁹⁷ Effective communication skills can help overcome these potential barriers.

Section 2.2: Health Literacy

Section 2.2.1: What is Health Literacy?

The 2004 IOM report, *Health Literacy: A Prescription to End Confusion*, stated that almost half of U.S. adults have low health literacy.¹ Health literacy is defined as “the degree to which individuals have the capacity to obtain, process, and

understand basic health information and services needed to make appropriate health decisions.”^{101(pvi)} Adequate health literacy is necessary for taking actions to obtain and maintain health; for access to and use of health care services; and for self-management of chronic health conditions.¹ Health literacy affects how individuals engage with the health care system and their providers, and how care is delivered.¹ Health literacy is influenced by many factors.¹ These factors include an individual’s knowledge, understanding, skills and abilities to engage with the health care system. Skills and abilities are influenced by the person’s education, culture, language and previous health care experiences. The health care system, with its complexity and demands, also is an important factor in determining an individual’s health literacy.¹

Low health literacy affects people of all ages, education levels, incomes, and races,^{1,30} and it disproportionately affects minorities and those with lower socioeconomic status.³⁰ Limited health literacy is a public health concern because it is associated with poor health outcomes for many health conditions including asthma; diabetes; and hypertension.¹⁻³ Compared to individuals who have adequate health literacy, individuals with low health literacy have less knowledge of their chronic health conditions,¹⁰² use fewer preventive health services,¹⁰³ and make more serious medication errors.^{2,104} Those with lower health literacy visit the emergency room more frequently¹⁰⁵ and have higher hospitalization rates compared to those who have adequate health literacy.¹⁰⁶ And, the elderly with low health literacy have higher mortality rates than their peers with adequate health literacy.^{107,108} Paasche-Orlow and Wolf (2007) suggested that health literacy is a determinant of health and influences

health outcomes through access to and utilization of care; provider-patient interactions; and self-care.⁵

Health care providers can decrease the demands the health care system places on patients, especially those with low health literacy, by taking a “health literacy universal precautions” approach to providing care.^{109(p1)} A “universal precautions” approach means practitioners assume that all patients may not fully understand health information and services.^{109(p1)} Thus, providers communicate in a clear and concise manner using plain language; they confirm patient understanding; and use forms and educational materials designed for low literacy audiences.¹¹⁰ A universal precautions approach helps decrease the burden placed on patients and caregivers and creates a shame-free environment.¹⁰⁹ This approach is necessary because health care providers and their staff do not always know who has low health literacy.¹¹¹ Many patients do not admit they have problems understanding health information or instructions because they are ashamed.¹¹² Patients with low health literacy are less likely to ask their provider questions than those with adequate health literacy,¹¹³ and providers do not always confirm their patients’ understanding of the health information or instructions they have given. For these reasons, patients with low health literacy may not benefit from the health information or instructions they receive from their provider.¹ It is incumbent upon health care providers to effectively communicate with their patients to minimize these potential barriers to delivering optimal care.

Section 2.2.2: What is Oral Health Literacy?

Healthy People 2010 defined oral health literacy as “the degree to which individuals have the capacity to obtain, process, and understand basic *oral* health information and services needed to make appropriate health decisions.”^{68(pg26)} This definition is consistent with the definition of health literacy.¹ Individuals most at risk for low oral health literacy are those with low income, low education, minorities and the elderly.^{113–115} Low oral health literacy is a public health issue because it is a potential barrier to the prevention, diagnosis and treatment of oral diseases.²⁷

Individuals with low oral health literacy are less likely to have the knowledge, understanding and skills to practice oral health promoting behaviors and to seek professional dental care.³¹ They are more likely to have lower levels of oral health knowledge and less likely to use preventive regimens than those with adequate oral health literacy.^{4,12–14,32,33} They are more likely to miss dental appointments.³⁸ Individuals with low oral health literacy are less likely to ask questions of their dental provider or to ask their provider to repeat information they do not understand.^{55,116,117} If individuals do not ask questions when they do not understand information or instructions, providers are less likely to know there is a problem. When dentists communicate clearly and confirm patient understanding, they increase the likelihood their patients understand health information, develop appropriate self-care routines and adhere to treatment plans,^{50,100} which can lead to better oral health outcomes.¹¹⁸

Adults with low oral health literacy are more likely to have poorer oral health^{12,13,34–36,38,119,120} and poorer self-rated oral health quality of life.⁷ For example,

they are significantly more likely to have a greater number of missing teeth than adults with adequate oral health literacy.^{9,10} The evidence of an association between oral health literacy and periodontal status is inconclusive. Two studies found individuals with low oral health literacy were more likely to have periodontal disease,^{36,37} but a systematic review did not find an association.⁶ Children of parents/caregivers with low levels of oral health literacy are more likely to experience negative oral health outcomes than children whose parents/caregivers have adequate oral health literacy.¹⁰³ These children are more likely to have dental caries, endodontic treatment and plaque.^{6,8,11,12}

Section 2.2.3: Dental Provider Communication Skills and Health Literacy

As mentioned in Section 1, we are interested in dentists' oral health knowledge and practices related to dental caries prevention because of dentists' role in delivering care to patients, which includes educating patients about oral health. There is relatively little research on dental provider-patient communication or dental provider health literacy. Some of the initial research about dental providers' communication skills was conducted by Rozier, Horowitz and Podshun (2011). They conducted a national survey of dentists about their routine use of communication techniques recommended to improve dentist-patient communication.⁶¹ The survey included a list of 18 communication techniques grouped into five domains. The domains are: interpersonal communication (five techniques), teach-back method (two techniques), patient-friendly materials and aids (three techniques), assistance (five techniques) and patient-friendly practice (three techniques).⁶¹ Literacy experts

consider interpersonal communication and teach-back methods basic skills that providers should routinely use and the other techniques are helpful for patients with low literacy skills.¹²¹ The authors found that routine use of all of the communication techniques was low. Dentists routinely used an average of 7.1 of the 18 techniques, and less than a quarter used the teach-back method. Other techniques such as presenting only a few concepts at a time and using videos were used infrequently.

Horowitz and colleagues (2013; 2013; 2015; 2016) surveyed six health care provider groups in Maryland, including general dentists, pediatric dentists and dental hygienists, using a survey instrument based on Rozier's survey.⁶²⁻⁶⁵ The authors found dentists' and dental hygienists' routine use of the communication techniques varied across the 18 techniques and was low for most techniques.^{62,65} General dentists reported routinely using a mean of 7.9 techniques and pediatric dentists reported routinely using a mean of 8.4 techniques.⁶² Dental hygienists reported routinely using a mean of 7.0 of the 18 communication techniques.⁶⁵ Respondents who had taken a communications course outside of dental or dental hygiene were more likely to use the techniques than those who had not taken such a course.

It has been over a decade since the national and Maryland state studies were conducted. The authors of the previous studies recommended communication skills courses in dental and dental hygiene schools as well as continuing education courses to improve dental professionals communication skills abilities.^{62,65} The NACHLD CAAP conducted this study to better understand the communications skills education

and training dental students receive. The NACHLD CAAP was also interested in students' education and training related to three caries preventive regimens.

Section 2.3: Dental Education: Communication Skills Education and Training

Section 2.3.1: The Need for Communication Skills Training

The importance of behavioral sciences in dental practice was recognized decades ago and the first guidelines for behavioral sciences instruction in dental school were developed in 1984.^{122,123} The guidelines were updated in 1993 to standardize the behavioral sciences component of the dental curricula.^{122,123} These guidelines included recommendations for didactic and clinical skills-based teaching in multiple areas including communication and interviewing; cultural awareness; and self-awareness.¹²⁴ In addition, over the past few decades both dental and public health organizations have recommended changes to the dental school curricula to prepare dental students to successfully serve a diverse patient population in the twenty-first century. Underlying some of the suggested changes is the need to communicate effectively with patients from diverse educational, cultural and economic backgrounds, and with patients with differing beliefs, preferences, and communication styles.¹²⁵

In 1990, the IOM Committee on the Future of Dental Education began an independent assessment of dental education and oral health in the United States at the request of dental educators.¹²⁵ The Committee's charge was to assess the status of dental education and oral health in the United States; consider future factors that could affect the population's oral health and the dental education system; make

recommendations to improve the population's oral health, the oral health care delivery system and dental education system; and provide strategies to help dental education, research and practice improve the nation's oral health.¹²⁵ The Committee's 1995 report, *Dental Education at the Crossroads: Challenges and Change*, included several recommendations on how to prepare dental students to serve a patient population that was becoming increasingly diverse and to treat more patients with chronic or complex medical problems. Two of the recommendations focused on serving patients. The first recommendation was for dental students and faculty to focus on patient-centered care that considers the patient's preferences and the second recommendation was to consider the language, culture, social, economic and emotional status of their patients.

Five years later, *Oral Health in America: A Report of the Surgeon General* provided a strong message to the nation by recognizing that "there are profound and consequential disparities in the oral health of our citizens" and a "silent epidemic of oral diseases is affecting our most vulnerable citizens – poor children, the elderly, and many members of racial and ethnic minority groups."¹¹⁴(pg7) The report stated that changing the public's perceptions of the importance of oral health and the relationship of oral health to general health was critical to improving the nation's oral health and eliminating oral health disparities. The authors recognized the importance of communication when they stipulated that oral health promotion and disease prevention messages must consider the different languages and cultures of the U.S. population. The report contained a framework for a national plan of action to address oral health disparities.

Also in 2000, the United States Department of Health and Human Services released *Healthy People 2010*, objectives that guide national health policies and programs.⁶⁸ The overarching goals for all focus areas were to eliminate health disparities including oral health disparities and increase quality of life and life span.⁶⁸ Health literacy was included in *Healthy People* for the first time in 2000 and was part of the Health Communication focus area. One goal in the Health Communication focus area was to improve health care provider communication skills. There were four objectives for this goal related to provider-patient communication skills. The first objective measured how well health care providers listen to their patients and the second objective measured how well health care providers explain information so their patients understand them. For new dental providers to develop adequate provider-patient communication skills to meet these *Healthy People* goals and objectives, they must receive training in dental school.

The 2003 *National Call to Action to Promote Oral Health (Call to Action)* was a response to the surgeon general's 2000 oral health report and the *Healthy People 2010* oral health objectives.¹²⁶ The *Call to Action*, created by leaders from public and private organizations, was a national plan that identified actions to improve oral health and eliminate disparities. The plan specified five actions. The first action, "change the perceptions of oral health" stressed the importance of implementing strategies at local, state, regional and national levels and for all population groups.^{126(p7)} Changing the perceptions of the importance of oral health is predicated on increasing the oral health literacy of the U.S. population. Adequate oral health literacy provides the foundation for individuals, policymakers and

communities to take actions to improve oral health. This first action stressed the importance of developing oral health messages that are concise and culturally sensitive, so the public understands why oral health is important, how to prevent diseases and to recognize when their oral health is not optimal. The fourth action acknowledged the need to increase the diversity of the dental workforce and identified the need to provide communication skills and cultural competence training to all health care providers and students.^{126(p14)} The aforementioned documents consistently point to the need for and importance of communication skills training for health care providers.

In 2006, the ADA identified limited health literacy as “a potential barrier to effective prevention, diagnosis and treatment of oral disease”.^{127(p317)} It also declared that “clear, accurate and effective communication is an essential skill for effective dental practice.”^{128(p454)} To increase health literacy in dentistry, the ADA’s Council on Access, Prevention and Interprofessional Relations (Council) and its National Advisory Committee on Health Literacy in Dentistry developed a strategic plan in 2009 to provide guidance to the association, its councils, dental professionals, and policymakers.¹²⁹ The Council identified five focus areas that reflected the five actions of the 2003 Call to Action.¹²⁶ The first focus area, *Training and Education* (to change perceptions of oral health) had two objectives.¹²⁹ First, educate the public and policy makers about oral health and its connection to general health, and second, encourage education and training about health literacy, including effective communication, in dental practice. One recommended strategy to support the second objective was to integrate communication skills training into multiple areas of dental

school curricula along with competence-based assessment of health literacy and communication skills. The fourth focus area, *Dental Practice*, had a primary goal of increasing communication and patient understanding in dental practice.

As outlined above, multiple public health and dental committees and organizations identified the need for dental practice to incorporate communication skills and health literacy. These organizations recommended modifying the dental school curricula to teach communication skills, interpersonal skills, cultural competency and health literacy to prepare future dentists to engage effectively with all patients. These skills are critical. They underlie the clinician's ability to interview patients to gather a complete health history; assess a patient's cognitive abilities and health literacy; communicate clearly and succinctly when providing oral health education and guidance; and communicate with empathy when discussing complex treatment options or bad news.¹²³

Section 2.3.2: Establishment of Communication Skills Competencies

In response to forces from within and outside the dental profession, the American Dental Education Association (ADEA) House of Delegates approved *Competencies for the New General Dentist* that included a "Communication and Interpersonal Skills" domain.^{130(p814)} In 2009, the CODA introduced two behavioral sciences standards for teaching and assessing competencies in communication skills for patient education and health promotion.²⁸ The first standard (2-15) requires "graduates to be competent in the fundamental principles of behavioral sciences as they as they pertain to patient-centered approaches for promoting, improving and

maintaining oral health.”^{28(p27)} The second standard (2-16) requires “graduates to be competent in managing a diverse patient population and have the interpersonal and communications skills to function successfully in a multicultural work environment.”^{28(p27)} Both organizations (ADEA and CODA) recognized effective communication as an essential skill critical to quality patient care. For patients to understand and act on oral health information and guidance, they must understand the information communicated by their dentist. Thus, it is incumbent upon dental schools to educate and assess students in these essential skills and for CODA to assess how dental schools’ curricula and examinations meet these competencies.

Section 2.3.3: How are Communication Skills Taught?

The CODA approved communication skills competencies for the dental curriculum eight years ago.²⁸ While communication skills training is an important aspect of dental education,^{48–50,57} there is limited published research about how dental schools have incorporated these competencies into their curriculum.^{19,46,47,51–56} Ayn and colleagues (2017) conducted a scoping review to identify a list of considerations for improving communication skills training in North American dental schools.¹³¹ They found variation in both the teaching and evaluation of communication skills courses. Studies also have found communication skills courses lack standardized practices in comparison to other technical dental skills.^{17,131} For example, different dental schools use different models to teach communication skills.⁵⁴ Three models are identified in the literature. Two models, the Macy Foundation Model and the Calgary-Cambridge Model, are based on patient-encounters in medicine.⁵⁴ The Macy

Foundation Model focuses on the provider-patient relationship and interviewing skills.¹³² The Calgary-Cambridge Model is a framework for teaching communication skills.¹³³ Haak and colleagues (2008) adapted the Calgary-Cambridge model to dental education.¹³⁴ The Manitoba model further adapted the Calgary-Cambridge Model to the dental patient encounter by including unique aspects of the dental visit such as a patient's inability to speak during procedures and dental fear.⁵⁵

Dental schools also differ in the types of communication skills courses offered. Some schools have distinct courses for teaching interpersonal and communication skills, while other schools include communication skills training within other courses.^{17,18,54} Methods for teaching communication skills also vary by dental school. The most frequently used methods to teach communication skills are lectures, presentations, role-playing, case studies, videos, student observation of faculty with real patients, and experiential learning with standardized and real patients.^{17,18,48–50,57} A common theme from researchers is that the more communication skills are integrated with general dentistry skills the more likely these skills will be perceived as relevant and practiced.^{49,53,54,56}

Section 2.3.4: How are Communication Skills Assessed?

There is limited information about how dental students' communication skills are assessed. The ADEA Commission on Change and Innovation in Dental Education (ADEA CCI) created the *Dental Student Assessment Toolbox (Toolbox)* to help educators assess students' mastery of the competencies for the new general dentist.¹³⁵ The *Toolbox* identifies four methods to assess communication skills: structured

faculty observation, peer assessments, patient surveys and standardized patients. Little research has been published about the methods used to teach and evaluate communication skills since CODA approved the communication skills competencies for the dental curriculum in 2009. Studies from three dental schools identify possible approaches and initial results of curriculum changes. These schools are the University of Alabama School of Dentistry, The University of Kentucky College of Dentistry and Rutgers School of Biomedical and Health Sciences.

The University of Alabama School of Dentistry uses structured assessments to evaluate dental students' communication skills during patient appointments.⁵³ The assessments focus on clinical communication and diagnosis. There are three parts to the assessments: faculty, student (self) and patient. For the assessment, the student must interact with a new patient, take a medical history, discuss oral health concerns, complete a clinical exam and provide treatment options. The student-patient interactions are assessed using the Four Habits Coding Scheme (4HCS) framework developed by Kaiser Permanente for effective communication during the clinical encounter.^{136,137} The University of Alabama selected the 4HCS framework because it is a tool for both instruction and assessment, and it covers the entire appointment. McKenzie's (2016) study of dental students' clinical communication skills found students were most effective at greeting patients, avoiding jargon, and non-verbal behaviors.⁵³ The skills the students were least effective at were testing patient comprehension and discussing perceived barriers to treatment.⁵³ The author suggested role-playing exercises and simulations to address these gaps in student communication abilities.

In a communications course at the University of Kentucky College of Dentistry, Aalboe and Schumacher (2016) developed an instrument to assess dental students' communication self-efficacy in six scenarios.⁵⁴ The scenarios were: patients anxious about undergoing dental procedures; patients experiencing dental pain; patients who need to change their oral health behavior; patients who have dental concerns; patients who need information about their treatment plan; and challenging patients. The authors measured communication self-efficacy because confidence in one's ability to communicate with patients in these typical practice situations is vital to students acquiring and using communication skills in their practice.⁵⁴

Some schools also use patient instructors (PI) or standardized patients, who are individuals trained to simulate a patient's condition in a standardized way.^{49,56} A study by Broder and Janal (2006) at the University of Medicine and Dentistry of New Jersey (now Rutgers School of Biomedical and Health Sciences), used PIs to evaluate interpersonal communication skills among third- and fourth-year dental students. The dental curriculum included two didactic courses on communication and interviewing and two follow-on clinical communications courses. The authors found that interpersonal communication skills significantly improved within each clinical communication course and between the first and second communication course.⁴⁹ They also found that communication skills scores were lower at the beginning of the second course than at the end of the first course, which suggests that communication skills can decrease without practice, and therefore need to be reinforced.^{49,56}

Dental schools use different approaches to communication skills training and assessment to address the competencies specified by CODA. The frameworks for teaching communication skills, the types and number of courses, and the evaluation methods differ by school. A few studies have assessed the different approaches to communication skills training and evaluation.^{49,53,54,56} However, there have been no national studies that surveyed dental students about the communication skills education and training they receive.

Section 2.4: Dental Caries

Section 2.4.1: Dental Education: The Need for Caries Prevention Education

Dental caries is a multi-factorial chronic disease whose burden is born unequally by low-income, minority, and elderly populations.^{114,138} Treating carious lesions by removing the diseased tissue and restoring with dental amalgam is an approach that has been used for decades, yet it does not stop the disease. It does not reduce the caries causing bacteria; it does little to decrease the risk of developing future carious lesions; and it does not improve oral health promoting behaviors in the population.^{139,140} To reduce the incidence of dental caries and decrease oral health disparities, dentistry must adopt a more conservative approach to caries management. The current evidence-based guidance for caries prevention supports this approach, which includes individualized risk assessment and disease management; accurate and early detection of caries lesions, and efforts to remineralize non-cavitated lesions to minimize operative intervention.^{25,140–142}

Over the past several decades expert panels have called for shift to a patient-centered and conservative approach to treating dental caries.^{23,25,40,140,143,144} Dental schools are critical to the efforts to change how dentists assess and manage dental caries because of their role in educating, training and mentoring new general dentists. There are many barriers to placing greater emphasis on caries prevention in dental education. In 2001, the Healthy People Curriculum Task Force (Task Force) conducted a study of U.S. and Canadian dental schools to assess classroom and clinical teaching of dental caries prevention.¹⁴⁵ They found dental schools take different approaches to teaching clinical preventive dentistry. Some schools had a formalized course in preventive dentistry while many integrated this material into other clinical disciplines. Few schools had numerical requirements (hours) in clinical caries prevention and a quarter of schools did not grade student clinical performance in any way. The task force identified barriers to integrating dental caries prevention into clinical teaching. The key barriers were: the teaching of prevention was inconsistent and fragmented; some faculty and students did not value prevention; some schools did not emphasize arresting dental caries with non-invasive techniques and licensure exams underemphasized prevention; some faculty did not follow clinical preventive guidelines; some preventive procedures were not reimbursed by insurance; and surgical procedures were reimbursed at a higher rate than time spent on caries risk assessment and non-surgical management of dental caries.

Another barrier to teaching preventive dentistry is the number of part-time dentists, many from private practice, who teach clinical courses. A national survey of dental faculty found 66 percent of clinical science faculty were part-time and 51

percent of new faculty were from private practice.¹⁴⁶ Potential problems with relying on part-time clinical faculty and those from private practice are that they may focus on treatment and not minimally invasive approaches to treating dental caries, and their training in preventive dentistry may not be current. Over the past decade, the number of part-time clinical faculty has increased,¹⁴⁶ which increases the odds that dental students may not be receiving optimal preventive dentistry training. To address these barriers, the Task Force developed a framework for teaching caries prevention in dental schools and ADEA endorsed it in 2007.

The ADEA *Competencies for the New General Dentist* mention caries prevention.¹³⁰ The competencies are organized into six domains. Two of the domains, health promotion and patient care, encompass caries prevention. In the health promotion domain, one competency (4.1) states that graduates must be able to “provide prevention, intervention, and educational strategies.”^{130(p814)} The patient care domain includes four competencies related to caries prevention. These competencies are: (6.1) Manage the oral health care of the infant, child, adolescent, and adult, as well as the unique needs of women, geriatric, and special needs patients; (6.2) Prevent, identify, and manage trauma, oral diseases, and other disorders; (6.4) Formulate a comprehensive diagnosis, treatment, and/or referral plan for the management of patients; and (6.11) Develop and implement strategies for the clinical assessment and management of caries.^{130(p815)} The domains and competencies do not identify specific approaches to caries prevention, but knowledge of and skills to use the three caries preventive regimens targeted by this research would be critical to meeting these competencies, especially competency 6.11.

Since the Task Force framework was adopted, over a third of the dental schools developed plans for improved preventive teaching.¹⁴⁷ Some dental schools have implemented risk assessment protocols, risk-based management, and non-surgical preventive regimens.^{40,43,148–151} In addition, members of the ADEA Section on Cariology developed a competency-based cariology curriculum to specify dental caries risk assessment, detection and management.⁴⁵ However, there is limited evidence on dental students' knowledge, attitudes and skills relating their caries prevention education. A study at one dental school by Autio-Gold and Tomar (2008) found that almost all (92 percent) students would use fluoride varnish for dental caries control, but approximately 40 percent were unsure of medical or dental risks associated with fluoride varnish.¹⁵² Almost 30 percent reported they would not use fluoride varnish for young pediatric patients (an ADA recommendation). On a positive note, over 80 percent of students indicated that training and practice of preventive dentistry should be increased. Thus, a second area of investigation for this dissertation research was to understand the education and training dental students receive related to caries risk assessment and three caries preventive regimens – fluoride varnish, dental sealants and silver diamine fluoride.

Section 2.4.2: What is Dental Caries?

Each tooth is composed of four dental tissues.¹⁵³ Three of the tissues, enamel, dentin and cementum, are hard calcified tissues. The fourth tissue, the pulp or center of the tooth, contains nerves, blood vessels and connective tissue; it is a soft non-

calcified tissue. The enamel is the outer layer of the tooth and the dentin is the tissue below the enamel and cementum.¹⁵³

Dental caries is a process of demineralization of tooth enamel that leads to destruction of the tooth enamel and dentin and results in tooth decay.¹⁵³ Generally, the decay process is gradual. When tooth decay progresses to a hole in the tooth enamel, this is a cavity. Initially the hole may be microscopic, but if left untreated, the decay penetrates the enamel layer. See Image: Anatomy of a Tooth.¹⁵³ Tooth decay is caused by bacteria that produce acid that destroys the surface of teeth.¹³⁸ The main bacteria involved in the decay process are *Streptococcus mutans*.¹³⁸ These bacteria feed on carbohydrates in the foods we eat, especially sugars, and produce acid. The acid causes calcium and phosphate to leave the enamel in a process called demineralization.¹³⁸ Remineralization can occur naturally when calcium and phosphorus reenter the enamel through saliva.¹³⁸ Demineralization is a slow process and it can be reversed using fluorides, but, if bacteria produce acid faster than the body can replace it, cavities form.

The earliest stage of tooth decay appears as a white spot on the tooth.¹³⁸ A white spot lesion is also called a non-cavitated lesion or an incipient lesion.¹³⁸ If decay is caught at this stage, it can be stopped and reversed. However, if the acid penetrates the enamel, a cavity results, and the tooth can no longer repair itself. If the cavity is not treated, it will grow into the soft tissue of the pulp causing an infection called pulpitis, which often causes severe pain. The infection can continue to spread to the root of the tooth creating an inflamed pocket called an abscess. The infection

can then travel from there into surrounding tissue and even enter the blood stream causing an infection that can be life-threatening.

Section 2.4.3: The Role of Fluoride in Preventing Dental Caries

There is over 70 years of evidence of the safety and effectiveness of fluoride to prevent dental caries and slow or reverse the progression of existing lesions.¹⁵⁴ Fluoride is the ionic form of the element fluorine and it occurs naturally in nature. Fluoride concentrated in plaque and saliva inhibits demineralization and enhances remineralization of the enamel, which helps control dental caries.^{155–157} There are three primary mechanisms by which fluoride works: 1) inhibiting demineralization at the crystal surfaces inside the tooth, 2) enhancing remineralization of the crystal surfaces, and 3) inhibiting bacterial enzymes.^{138,158} Fluoride enhances remineralization by adsorbing to the tooth surface and attracting calcium ions present in saliva. It acts to bring the calcium and phosphate ions together and is included in the chemical reaction that takes place, producing a crystal surface that is less soluble in acid than the original tooth mineral.¹⁵⁸ Also, fluoride is taken up by cariogenic bacteria when they produce acid. Once inside the cells, fluoride interferes with the enzyme activity of the bacteria. This interference reduces bacterial acid production which reduces the dissolution rate of tooth mineral.

Fluoride is available through self-applied products, professional products and community water fluoridation (CWF).^{155,158} Self-applied topical products include toothpaste, mouth rinse and gels. Professionally applied topical fluorides include rinses, gels and foams that are higher strength than self-applied products; fluoride

varnishes and silver diamine fluoride. Community water fluoridation is the process of adjusting the amount of fluoride found in water to achieve optimal prevention of tooth decay.¹⁵⁹ Drinking fluoridated water reduces cavities by about 25 percent in children and adults.¹⁶⁰ While CWF is not the focus of this research, it is important to mention because it is the most equitable and cost-effective way to make fluoride available to all members of most communities.¹⁶¹ It is especially beneficial for low-income communities that have less access to dental-care and other sources of fluoride than higher income communities.¹⁶² The Centers for Disease Control and Prevention named CWF as one of the ten great public health achievements of the 20th century because of its contribution to the decline in cavities since the 1960s.¹⁶¹

Section 2.4.4: Dental Caries Incidence and Prevalence in the United States

Dental caries (tooth decay) is the most common chronic disease in children and adolescents, and most adults have or have had some tooth decay.^{113,163–165} We know how to prevent dental caries.^{25,114,141,144} Yet, large numbers of individuals in the United States suffer from this disease and the burden is disproportionately borne by low-income, minority and elderly populations.^{113,115,163} The costs for this disease, both monetary and impact on the quality of life, are high. Untreated dental caries affects the ability to eat, get proper nutrition, speak, and sleep.^{114,166–168} For children, it negatively impacts their ability to learn and results in missed school days.¹⁶⁹ For adults, it affects work performance, work attendance and employability.¹⁷⁰ Untreated dental caries can lead to loss of teeth, which negatively affects physical appearance, lowers self-esteem, limits social interaction and lessens overall quality of life.^{167,168,170}

Untreated dental caries results in acute and chronic infections; causes pain and suffering; and can result in hospitalization and high treatment costs.^{114,171–174}

The National Health and Nutrition Examination Survey (NHANES) collects oral health and dental care data that is used to assess the nation's progress in achieving its oral health objectives.⁶⁸ Key NHANES measures include untreated dental caries, treated dental caries, application of dental sealants, periodontal status, tooth loss, and dental visits.¹⁷⁵ Dye and colleagues (2015) conducted an analysis of dental caries and untreated dental caries in children and adolescents for the period of 2011-2012 using NHANES data.¹⁶⁴ Overall, the prevalence of dental caries in primary teeth decreased from 42 percent (1999-2004) to 37 percent (2011-2012).^{113,164} For children aged 2 to 5 years, the prevalence of dental caries in primary teeth decreased from 28 percent (1999-2004) to 23 percent (2011-2012).^{113,164} For youth aged 6 to 11 years, the prevalence of dental caries in permanent teeth was similar (21 percent) between the two reporting periods (1999-2004 and 2011-2012), and the rate of untreated dental caries decreased from 8 percent to 6 percent.^{113,164} The prevalence of dental sealants on permanent teeth among youths 6 to 11 years increased from 30 percent to 40 percent between the two periods.^{113,164}

For adolescents, the rates of dental caries and untreated dental caries in permanent teeth decreased from the two previous reporting periods (1988-1994 and 1999-2004). Fifty-eight percent of adolescents had dental caries (2011-2012) vs. 59 percent (1999-2004), and there were no significant differences by race or Hispanic origin as for the previous period.^{113,164} Fifteen percent of adolescents had untreated

dental caries, a decrease from 20 percent in the 1999-2004 period.^{113,164} Untreated dental caries was higher for non-Hispanic black adolescents (21 percent) compared to non-Hispanic white (13 percent) or non-Hispanic Asian (12 percent) adolescents. The prevalence of dental sealants on permanent teeth among adolescents was 43 percent (2011-2012) compared to 38 percent (1999-2004 period).^{113,164}

Dye and colleagues (2007) also examined NHANES oral health data for adults. For adults aged 20 to 64 years, the prevalence of coronal caries decreased from 95 percent to 92 percent between the two periods, with the largest decline for those aged 20 to 34 years.¹¹³ The prevalence of root caries (the part of the tooth embedded in the jaw) decreased from 19 percent to 14 percent between the two periods, with the greatest decrease seen in adults aged 50 to 64 years.¹¹³ With regard to untreated dental caries, there was an overall decrease in the prevalence of untreated dental caries for adults, but the decrease was only significant for non-Hispanic blacks.¹¹⁵ For all adults, tooth retention significantly increased from approximately 24 teeth to 25 teeth between the two periods (adults with a full dentition have 32 teeth). The prevalence of edentulism (missing all teeth) decreased from 6 percent to 4 percent, with the greatest decline for individuals aged 50 to 65 years.¹¹³

For seniors aged 65 years and older, the prevalence of coronal caries was unchanged between the two periods, but the prevalence of untreated coronal caries significantly decreased from 28 percent to 18 percent between the two periods. The prevalence of root caries decreased from 46 percent to 36 percent between the two periods, with the greatest decrease seen in adults living below 100 percent of FPL.¹¹³

The prevalence of tooth retention significantly increased from 17.9 teeth to 18.9 teeth between the two periods and the prevalence of edentulism decreased from 34 percent to 27 percent.¹¹³

In summary, the prevalence of dental caries in the United States. has declined over the past 25 years.^{113,114,163,164} The decrease can be attributed to widespread exposure to fluorides such as fluoridated water, fluorides (varnishes, gels and tablets) and fluoride toothpaste.¹¹⁴ Additionally, there is greater awareness among the public and health professionals about the importance of oral health and maintaining good oral hygiene.¹¹⁴ However, not all population groups have experienced this decrease in dental caries. Dental caries prevalence varies by income, race and ethnicity and age – some racial and ethnic minorities and those who are low income experience greater prevalence of dental caries and untreated dental caries.^{113,114,163,164} One approach to decreasing oral health disparities is to educate and train dental students in caries preventive regimens to help stop the disease before it takes hold.

Section 2.4.5: Three Caries Preventive Regimens

The section describes the three caries preventive regimens in this study. Each regimen is defined; evidence for the effectiveness of the regimen is summarized; and guidance from key health organizations on clinical use of the regimen is summarized.

Section 2.4.5.1: Fluoride varnishes

There are several types of professionally applied fluoride; fluoride varnish is the most widely used fluoride in clinical practice today.²⁵ Fluoride varnishes are a resin-based

fluoride that is painted directly onto the tooth.^{25,176} Fluoride varnishes provide extra protection against tooth decay when used in addition to brushing teeth regularly with fluoride toothpaste.²⁵ Varnishes are highly effective in reducing caries or inhibiting progression of caries in primary and permanent teeth.^{21,25,176–178} Fluoride varnishes were originally developed in the 1960s and 1970s to prolong contact time between fluoride and tooth enamel to prevent the immediate loss of fluoride after application. Varnishes deliver fluoride to the tooth enamel surface and to subsurface carious lesions, where it forms deposits of calcium fluoride and provides a reservoir of fluoride ions.^{176,178} The United States Food and Drug Administration (FDA) approved fluoride varnishes use as a cavity liner and/or tooth desensitizer and they are used “off-label” for preventing dental caries.¹⁷⁹

Section 2.4.5.1.1: What is the evidence for the effectiveness of fluoride varnishes?

In 2006, the ADA Council on Scientific Affairs (CSA) convened a panel to examine whether the use of a topical fluoride agent reduces the incidence of new lesions in coronal caries, root caries or both compared with no topical fluoride use in both primary and permanent teeth.¹⁸⁰ The crown is the portion of the tooth covered by enamel and the root is the portion of the tooth embedded in jaw.¹⁵³ The CSA recommendations, stratified by age groups and caries risk, indicated that periodic fluoride treatments should be considered for both children and adults who are at moderate or high risk of developing caries.¹⁸⁰ The recommendations were: 1) Age younger than six years: those at moderate risk should receive fluoride varnish applications at 6-month intervals and those at higher risk should receive fluoride varnish applications at 3- to 6-month intervals; 2) Age 6-18 years: those at moderate

risk should receive fluoride varnish or gels at 6-month intervals. Those at higher risk should receive fluoride varnish or gel application at 6-month intervals and applications at 3-month intervals may provide additional benefit; 3) Older than 18 years: those at moderate risk should receive fluoride varnish or gels at 6-month intervals and those at higher risk should receive fluoride varnish or gel application at 3- to 6-month intervals; and 4) All ages: application time for fluoride gel and foam should be four minutes.

In 2013, Weyant and colleagues conducted a systematic review of professionally applied fluoride varnishes and updated the 2006 CSA clinical recommendations.²⁵ The review included 71 trials from 82 articles and assessed the efficacy of various topical fluoride caries-preventive agents. The panel recommended the use of fluoride varnishes for individuals who are at increased risk of developing dental caries. The recommendations were as follows: Age younger than six years – 2.26 percent fluoride varnish at least every three to six months; for age groups 6-18 years, older than 18 years and adult root caries – 2.26 percent fluoride varnish at least every three to six months or 1.23 percent fluoride (APF or acidulated phosphate fluoride) gel for four minutes at least every three to six months. Adults at low risk of developing dental caries may not need additional topical fluorides other than over-the-counter fluoridated toothpaste and fluoridated water.

Marinho and colleagues (2013) conducted a systematic review of the effectiveness of fluoride varnishes to prevent dental caries in children and adolescents.²¹ The authors examined 22 clinical trials conducted between 1975 and

2012 in which a total of 12,455 children were randomized to treatment with either fluoride varnish or placebo/no treatment. The authors included studies of fluoride varnishes using any agent, at any concentration, amount or duration of application and with any technique of application. The only requirement was that the frequency of application was at least once a year. The trials were conducted in nine countries including the United States.²¹ The ages of the children at the start of the trials ranged from 1 to 15 years, with similar numbers from both sexes.²¹ The main question addressed by the review was how effective fluoride varnish was for the prevention of caries in children as compared with placebo or no treatment. The results from the meta-analysis of the 13 trials assessing the effect of fluoride varnish on the permanent teeth showed that the use of fluoride varnish is associated on average with a 43 percent (95% CI 30% to 57%) reduction in decayed, missing and filled tooth surfaces. The meta-analysis of the 10 trials assessing the effect of fluoride varnish on the primary dentition showed a 37 percent (95% CI 24% to 51%) reduction in decayed, missing and filled tooth surfaces. This review of 22 clinical trials found that fluoride varnish, compared with placebo or no treatment, is effective in the prevention of caries in children and adolescents.²¹

The U.S. Preventive Services Task Force (USPSTF) reviewed the evidence for the effectiveness of fluoride varnish in preventing dental caries and published their recommendations in 2014.¹⁸¹ The USPSTF “*found adequate evidence that oral fluoride supplementation, also known as dietary fluoride supplementation, in children who have low levels of fluoride in their water and application of fluoride varnish to the primary teeth of all children can each provide moderate benefit in preventing*

dental caries.”^{181(p1104)} Thus, the USPSTF recommended that “*primary care clinicians prescribe oral fluoride supplementation starting at age 6 months for children whose water supply is deficient in fluoride and apply fluoride varnish to the primary teeth of all infants and children starting at the age of primary tooth eruption.*”^{181(p1103)} The recommendation was directed at primary care clinicians because children see a primary doctor more frequently than a dental provider, especially children ages 5 years and younger. The USPSTF concluded that there was limited evidence about the harms associated with fluoride varnish or other preventive interventions for dental caries, but that these risks are likely small.¹⁸¹ Therefore, it is important to consider a child’s overall systemic exposure to fluoride from multiple sources, such as water fluoridation, toothpaste, supplements, and/or varnish, to prevent over exposure to fluoride.¹⁸² The recommendation stated that the optimum frequency of fluoride varnish application in children is not known, but their recommendation was based on three studies judged as fair-quality with application periods of once and twice-yearly.

Also in 2014, the American Academy of Pediatric Dentistry (AAPD) reviewed the scientific literature on the use of fluorides to prevent dental caries and updated their guidelines.¹⁸³ The AAPD guidelines state that there is evidence from randomized controlled trials and meta-analyses that professionally applied topical fluoride treatments (fluoride varnishes) are effective in reducing dental caries in children at risk for caries.¹⁸³ The guidelines state that preschool children should receive a professional fluoride treatment at least every six months if they are at moderate risk for dental caries and every 3- to 6- months if they are at high risk. Risk

should be assessed over time and the type and frequency of preventive interventions should be adjusted to risk level.¹⁸³

Section 2.4.5.2: Silver Diamine Fluoride

Silver diamine fluoride is a topical treatment used to prevent and arrest dental caries and relieve dental hypersensitivity.¹⁴² It is a colorless liquid containing silver particles and 38 percent fluoride ion that at a pH of 10 is 25 percent silver, 8 percent ammonia, 5 percent fluoride, and 62 percent water.¹⁸⁴ Silver diamine fluoride acts in two ways. The silver acts as an anti-microbial agent killing bacteria and preventing the formation of new biofilm and the fluoride acts to prevent further demineralization of the tooth.¹⁴² While silver diamine fluoride has been used extensively outside the United States for caries control for many years,¹⁸⁴ it was not until 2014 that the FDA cleared silver diamine fluoride as a desensitizing agent, similar to fluoride varnish 20 years ago.¹⁸⁵ The FDA also granted the single manufacturer of silver diamine fluoride in the United States “breakthrough therapy status,” allowing clinical trials of silver diamine fluoride for caries arrest.^{185(p1)} In the United States silver diamine fluoride is currently used off-label for caries arrest while clinical trials are evaluating its effectiveness in treating dental caries.

In other countries silver diamine fluoride is used to treat dental caries in people who are unable to access dental treatment or tolerate conventional dental care, including very young children, persons with intellectual/developmental disabilities and older adults.¹⁸⁵ It can be applied to teeth as soon as dental caries are detected. The topical application of silver diamine fluoride is a noninvasive procedure; it is quick

and simple to use. silver diamine fluoride arrests active carious lesions painlessly and without local anesthetic (as long as the teeth are asymptomatic) avoiding or delaying traditional surgical removal of caries.^{184,186} The silver particles in silver diamine fluoride blacken active dental caries, which may be a concern with patient/parent acceptance, but it does not stain sound enamel. If unprotected soft tissues come in contact with silver diamine fluoride, they are temporarily stained.

Section 2.4.5.2.1: What is the evidence for the effectiveness of silver diamine fluoride?

Outside the United States, silver diamine fluoride has been shown to be effective in arresting dentinal caries in primary teeth^{186–188} and in caries control and management in root caries in the elderly.^{189,190} Rosenblatt and colleagues (2009) conducted a systematic review to examine whether silver diamine fluoride is more effective at preventing dental caries than fluoride varnish.¹⁸⁴ The review identified 99 human clinical trials in three languages published between 1966 and 2006, but only two met their inclusion criteria.¹⁸⁴ The two studies examined the effect of silver diamine fluoride following application to primary teeth or both primary and permanent teeth in children.^{187,191} The frequency of silver diamine fluoride application was either biannual or annual; trial duration ranged from 2.5 years to 3 years; and the silver diamine fluoride silver diamine fluoride concentration was the same for both studies (38 percent).^{187,191} Results from both studies indicated that silver diamine fluoride was effective in arresting and preventing caries.^{187,191}

A recent systematic review by Contreras and colleagues (2016) evaluated the effectiveness of silver diamine fluoride in preventing and arresting caries in the primary dentition and permanent first molars.¹⁸⁶ The review identified 821 studies published in English between 2005 and January 2016, but only seven met their inclusion criteria. The studies included one that assessed the effectiveness of silver diamine fluoride at different concentrations; three that compared silver diamine fluoride with other interventions; two that compared silver diamine fluoride at different application frequencies and with other interventions; and one study comparing semiannual silver diamine fluoride applications versus a control group. The authors concluded that silver diamine fluoride is a preventive treatment for dental caries in community settings. Further, at concentrations of 30 percent and 38 percent, silver diamine fluoride shows potential as an alternative treatment for caries arrest in the primary dentition and permanent first molars. The authors concluded that more studies are needed to fully assess the effectiveness of silver diamine fluoride to establish guidelines and to determine the appropriate application frequency.

In October 2017, the AAPD issued guidelines for the use of silver diamine fluoride for dental caries management in children and adolescents in clinical practices.²⁴ The guidelines, based on analysis of data included in a recent systematic review and meta-analysis by Gao and colleagues (2016), summarized evidence of the benefits and safety of silver diamine fluoride application in the context of dental caries management, mainly its effectiveness in arresting cavitated caries lesions in the primary dentition.¹⁹² The AAPD supports the use of 38 percent silver diamine fluoride (the only formula available in the United States) for the arrest of cavitated

caries lesions in primary teeth as part of a comprehensive caries management program. The guidelines state that based on the pooled estimates of the silver diamine fluoride group, approximately 68 percent (95% CI=9.7 to 97.7) of cavitated caries lesions in primary teeth would be expected to be arrested two years after silver diamine fluoride application (with once or twice a year application). Using data with the longest follow-up time (at least 30 months follow-up; n=2,567 surfaces from one randomized controlled trial (RCT)¹⁸⁷ and one controlled clinical trial (CCT)),¹⁹¹ silver diamine fluoride had a 48 percent higher (95% CI=32 to 66) success rate in caries lesion arrest compared with the controls (76 percent versus 51 percent arrested lesions). In other words, 248 more cavitated caries lesions would be expected to arrest by treatment with silver diamine fluoride compared with control treatments, per 1000 surfaces after at least 30 months followup.²⁴

Based on a review of the limited evidence, the AAPD made a conditional recommendation regarding the use of silver diamine fluoride for the arrest of cavitated caries lesions in primary teeth as part of a comprehensive caries management program. Because untreated tooth decay in young children is an immense public health challenge, use of silver diamine fluoride could positively impact the health and quality of life of young children.¹⁷¹ In addition, use of silver diamine fluoride could reduce both costs and health risks for children with extensive dental caries because silver diamine fluoride does not require hospitalization and general anesthesia as is the case with the current treatment approach for children with extensive dental caries.^{174,193} Treatment is disproportionately costly when general anesthesia during hospitalization is required.¹⁹⁴ Studies show that children from less-

affluent communities have higher dental surgery rates than those from more-affluent communities (25.7 vs. 6.9 per 1,000),¹⁹⁵ which results in an economic burden for communities already impacted by the effects of poverty-related health problems.^{193,196} In making its recommendation, the AAPD panel considered silver diamine fluoride's efficacy, low cost and that it is minimally invasive. The panel concluded that the undesirable effects of silver diamine fluoride (mainly esthetic concerns due to dark discoloration of caries silver diamine fluoride treated teeth) were outweighed by its desirable properties in most cases, while no toxicity or adverse events associated with its use have been reported.²⁴

Section 2.4.5.3: Dental Sealants

Pit and fissure sealants, also called dental sealants, are a clear or opaque plastic material applied to the chewing (occlusal) surface of permanent molars and premolars to prevent cavities.²³ The occlusal surface of these molars has pits and fissures that make them vulnerable to decay. The purpose of dental sealants is to provide a physical barrier to protect the pits and fissures of the permanent molars from bacteria and food and prevent cavities. Additionally, dental sealants can inhibit the progression of non-cavitated caries lesions. Dental sealants were introduced in the 1960s to help prevent dental caries, mainly in the pits and fissures of occlusal tooth surfaces.²² While they are one of the most effective interventions for preventing dental caries, they are underutilized.¹⁶⁴

Dental sealants should be applied to permanent molars *as soon as the teeth come in to protect them from decay*.¹⁹⁷ The first permanent molars come in between the ages of 5 and 7 and the second permanent molars come in between the ages of 11

and 14 years. Additionally, teenagers and young adults who are prone to decay may also need sealants.¹⁹⁷ Dental sealants can last up to 10 years, but they need to be checked at regular dental check-ups to make sure they are not chipped or worn away. A number of studies have shown that dental sealants are a cost-effective intervention to prevent dental caries.^{198,199} Applying dental sealants to children's and adolescent's permanent molars reduces costs by delaying and preventing the need for invasive restorative treatment, especially for individuals that are identified as having increased risk for dental caries.

Section 2.4.5.3.1: What is the evidence for the effectiveness of dental sealants?

In 2008, the ADA CSA convened an expert panel to develop evidence-based clinical recommendations for the use of dental sealants.¹⁴⁴ Two of the questions the panel considered were: “*Under what circumstances should sealants be placed to prevent caries?*” and “*Does placing sealants over early (non-cavitated) lesions prevent progression of the lesion?*”¹⁴⁴⁽²⁵⁹⁻⁶⁰⁾ A review of the evidence found that resin-based dental sealants on the permanent molars of children and adolescents are effective for caries reduction. The reduction in dental caries incidence in children and adolescents ranged from 86 percent at one year to 78.6 percent at two years and 58.6 percent at four years after sealant placement. Dental sealants were effective in reducing occlusal caries incidence in permanent first molars of children, with reductions of 76.3 percent at four years, when sealants were reapplied as needed. Nine years after initial sealant placement, caries reduction was 65 percent. Dental sealants were retained on primary molars at a rate of 74.0 to 96.3 percent at one year and 70.6 to 76.5 percent at 2.8 years. Importantly, the panel found evidence from

private dental insurance and Medicaid databases that placement of dental sealants on first and second permanent molars in children and adolescents was associated with reductions in the subsequent need to provide restorative treatment. With regard to the effectiveness of dental sealants to prevent the progression of non-cavitated lesions, the panel found that dental sealants significantly reduced the percentage of non-cavitated carious lesions that progress in children, adolescents and young adults for as long as five years after sealant placement compared with unsealed teeth.

In 2016, the ADA CSA and the ADA Center for Evidence-Based Dentistry, in collaboration with the AAPD convened a working group to develop a systematic review and evidence-based clinical practice recommendations for the use of dental sealants.¹⁴¹ The goal of the 2016 clinical practice guideline was to provide updated evidence-based recommendations regarding when and how the placement of pit-and-fissure sealants is most likely to be effective in preventing carious lesions on the occlusal surfaces of primary and permanent teeth in children and adolescents, and if dental sealants should be used (in pits and fissures of occlusal surfaces of primary and permanent molars on teeth deemed to have clinically sound occlusal surfaces or non-cavitated carious lesions) compared with fluoride varnishes. The panel made a strong recommendation for the use of dental sealants compared with nonuse in primary and permanent molars with both sound occlusal surfaces and non-cavitated occlusal carious lesions in children and adolescents. The recommendation is only for children and adolescents because the panel did not identify studies in adult patients.

The panel made a conditional recommendation for the use of sealants

compared with fluoride varnishes in primary and permanent molars, with both sound occlusal surfaces and non-cavitated occlusal carious lesions, in children and adolescents. The recommendation was conditional due to the low quality of the evidence. The panel said more research was needed on other noninvasive approaches for dental caries arrest on occlusal surfaces of primary and permanent molars. The panel also looked at the evidence for adverse health effects when using dental sealants, specifically related to the presence of bisphenol A (BPA) in dental sealants. They found the evidence does not support the small amount of BPA in dental sealants placing patients at risk.²⁰⁰ Finally, the panel noted that dental sealants are more effective in preventing dental caries on occlusal surfaces than using fluoride varnishes only.²⁰¹

Both the 2008 and 2016 ADA expert panels specified that placement of dental sealants requires a ‘dry field’ be maintained during placement. A dry field means the site on which the sealant is to be placed needs to be isolated from saliva. Placement of dental sealants is very technique dependent and not maintaining a dry field is a common reason of sealant failure.^{141,144} Some dentists are reluctant to use this preventive regimen and the reasons include sealant failure, low insurance reimbursement rates (especially from Medicaid) and dentists did not learn to apply dental sealants in dental school.^{141,144,202}

Successful placement of dental sealants is dependent on provider skill, and when placed correctly they are cost effective in preventing dental caries. Chi and colleagues (2013) conducted a study related to the costs of dental sealants by

examining Medicaid reimbursement data for dental sealants on primary molars.²⁰³ All 50 Medicaid programs reimbursed dentists for placement of dental sealants on permanent teeth, but only 17 programs reimbursed for dental sealants placed on primary molars. The mean reimbursement rate for dental sealants on primary teeth was \$27.57 (ranging from \$16 in Maine to \$49.68 in Alaska). The authors recommended all state Medicaid programs reimburse for dental sealants on primary molars because of the long-term positive oral health benefits and cost savings due to decreased future treatment needs. Another study by Chi and colleagues (2014) examined Iowa Medicaid claims data (2008–2011) and compared the incremental cost-effectiveness of two primary molar sealant strategies—always seal and never seal—with standard care (restoration or extraction) for Medicaid-enrolled children.²⁰⁴ In comparison to standard care, always sealing primary molars is costlier but reduces subsequent dental treatment. Never sealing primary molars costs less but leads to more treatment, which can be costlier in the long term. The authors recommended that State Medicaid programs that do not currently reimburse dentists for primary molar sealants should consider reimbursement for primary molar sealant procedures as a population-based strategy to prevent tooth decay and to reduce later treatment needs in vulnerable young children.

A community-based approach to decreasing dental caries is to apply dental sealants through school-based programs. The Community Preventive Services Task Force (CPSTF), an independent panel of public health and prevention experts, evaluated evidence from a high-quality systematic review and four studies of dental sealant application within the school setting. The CPSTF recommends school-based

dental sealant programs based on strong evidence for the effectiveness of these programs.²⁰⁵ Two studies assessed the number of children receiving sealants in schools with and without school-based sealant delivery programs. Results from both studies showed that implementing a dental sealant delivery program led to an increase in the number of children with sealants. The increase in dental sealant application included both lower and higher risk children, which reduced the disparity between risk groups. These community-based programs are an important approach to providing this preventive regimen to low-income children who are at higher risk for dental caries and also less likely to access dental care.

Finally, a recent systematic review by Ahovuo-Saloranta and colleagues (2017) evaluated the effectiveness of different types of dental sealants in preventing dental caries in occlusal surfaces of permanent teeth in children and adolescents.²² The review included 38 clinical trials that involved a total of 7924 children who ranged in age from 5 to 16 years. Fifteen trials evaluated the effects of resin-based sealant versus no sealant (3620 participants in 14 studies); three trials evaluated glass ionomer sealant versus no sealant (905 participants); and 24 trials evaluated one type of sealant versus another (4146 participants). Trials rarely reported background exposure to fluoride of trial participants or baseline caries prevalence. The authors concluded that resin-based dental sealants applied on occlusal surfaces of permanent molars are effective for preventing caries in children and adolescents. The review found moderate-quality evidence that resin-based sealants reduced caries by between 11 percent and 51 percent compared with no sealant when measured at 24 months. A similar benefit was seen at time points up to 48 months. The authors found

insufficient evidence to judge the effectiveness of glass ionomer sealants or the relative effectiveness of different types of sealants.

In summary, dental sealants are a safe and effective way to prevent dental caries in children and adolescents. Dental sealants are cost effective in the short term and over time, and they reduce treatment needs and costs. They provide a population-based approach to preventing tooth decay, especially for low-income children and adolescents, and they reduce the monetary and quality of life costs associated with tooth decay. Unfortunately, dental sealants are underutilized. To increase the application of dental sealants, new dentists must have the knowledge, skills and SE to apply dental sealants. Additionally, they should support community-based approaches such as school-based sealant programs to decrease the number of low-income children with dental caries.

Section 2.5: Theoretical Framework

Section 2.5.1: Use of Behavioral Theory in Dental Education

In our review of the literature we did not find studies about the use of health behavior theories to develop dental school education courses. With regard to medical education, we found books and peer-reviewed publications that discussed the importance of using health behavior theories for course development, teaching and student evaluation.²⁰⁶ The two theories cited most frequently in the medical education literature were Social Cognitive Theory (SCT)⁵⁸ and the Theory of Planned Behavior (TPB).^{207–209}

Mann (2011) described the applicability of SCT to medical education because

SCT recognizes the effect of the environment on learning;²¹⁰ SCT supports the design of medical education classes because learning through observation and then engaging in the behavior is a core principle of SCT and medical education.²¹¹ Additional evidence of the applicability of SCT to the design of medical education courses comes from Torre and Durning (2015) in their chapter in *Researching Medical Education*.²¹² They state that the SCT concept of learning within the social environment is a good model for teaching and learning in the complex medical education environment because it can provide a better understanding of individual and cognitive processes.

The TPB was frequently cited in the literature. Most publications were about interventions for changing the behaviors of patients and health care professionals. For example, a systematic review by Godin and colleagues (2016) examined factors influencing health professionals' behaviors based on health behavior theories.²¹³ The theories cited most frequently in this review were the Theory of Reasoned Action (TRA)⁶⁰ and the TPB.²⁰⁸ Of the 78 studies that met their inclusion criteria, 72 studies provided information on the determinants of intention and 16 studies provided information on the determinants of behavior. The overall frequency-weighted R^2 values for the prediction of behavior and the prediction of intention were 0.31 and 0.59, respectively, indicating these two constructs accounted for a significant amount of the variance in these studies.

In a series of implementation research studies, Eccles and colleagues (2012) investigated the use of theory to transfer research findings into practice in health care settings in the United Kingdom.^{214,215} The research team developed questionnaires

based on six theories to explore five behaviors with general medical and general dental practitioners. Variables were drawn from the TPB,²⁰⁸ SCT,⁵⁸ Operant Conditioning,²¹⁶ Implementation Intentions,²¹⁷ Self-Regulation Model,²¹⁸ and Transtheoretical and Precaution Adoption Process models.²¹⁹ Two of the six behaviors were dental related - the number of x-rays taken per treatment plan and intention to apply dental sealants. The researchers used structural modeling to investigate the relationships between predictor variables (theoretical constructs) and outcome measures (data on performance) and whether outcomes were modified by behavior, professional group or geographic location. The goal of the research was to assess which constructs from which theories explained more variance in health care provider behavioral outcomes.

In one study, an intervention designed to reduce the number of x-rays routinely taken by dentists, the primary outcome was the number of intra-oral x-rays taken per treatment plan. At the theory level, the TPB explained 13 percent of the variance in the number of x-rays taken, and SCT explained 7 percent. Measures that predicted the number of x-rays taken also predicted intention to take x-rays, and intention accounted for significant variance in behavior.²²⁰ In a second study by this team, the outcome measure was dentists' intention to place dental sealants on second molars.²²¹ The variables that predicted behavioral intention were attitude, risk perception, outcome expectancies, self-efficacy, anticipated consequences of the behavior, experienced consequences and habit. The TPB constructs explained 16 percent of the variance in behavioral intention and the SCT constructs explained 31 percent of the variance. The authors concluded that using theoretical models can be

useful in understanding and predicting clinical practice requiring clinicians' behavior change.^{214,220–222} This series of studies showed variability in the reported behavior related to the types of health care providers and the specific behaviors studied.²²²

In summary, we did not find studies in dental education that used behavioral theories as the basis for developing courses. We did find studies from medical education that used SCT and the TPB constructs to evaluate student learning.^{206,210,212,213,223} We also found a few studies that evaluated behavior change in medical and dental providers based on SCT and the TPB constructs.^{213,214,220,222,224} Based on these studies, we think constructs from SCT and the TPB are a reasonable foundation for our conceptual model.^{58,207,208}

Section 2.5.2: Theoretical Constructs Used in the Study

The conceptual framework of this study was based on SCT and the TPB constructs.^{58,207,208} The premise of SCT is that we learn from and by interacting with others and our environment.⁵⁸ The theory posits that behavior is a function of the continuous, dynamic and reciprocal interaction among three factors: personal, behavioral and environmental.⁵⁸ Personal factors include an individual's knowledge, skills, attitudes, perceptions, expectations, values and past experiences.²²⁵ The environment includes factors external to the person that may facilitate or hinder learning.²²⁵ Behavior is the third interacting determinant, and it is influenced by cognitive processes and environmental stimuli.²²⁵ According to Bandura, these three factors exert different levels of influence on a behavior based on the individual, the activities and the situation.²²³ For example, the environment will be the dominant factor when students work in a busy dental clinic. Behavior is the dominant factor

when students are learning and practicing a new skill, such as filling a cavity.

Personal factors such as the student's values and goals will have the strongest influence when the influences of environment and behavior are not as strong.²²³

The study used two SCT constructs and one TPB construct. The two SCT constructs are Behavioral Capability and Self-efficacy and the TPB construct is Behavioral Intention.^{58,225} Behavioral Capability is the individual's ability to use knowledge and skills to perform a behavior²²³ and self-efficacy is an individual's confidence to perform a behavior to attain specific results, and overcome barriers to performing the behavior.²²⁵ Self-efficacy is influenced by a person's capabilities and by environmental factors that act as enablers or barriers to performing the behavior.²²⁵ Self-efficacy influences many aspects of behavior. It affects the types of behaviors an individual will attempt; the level of difficulty of the goals set; the effort the individual is willing to put towards achieving their goals; how long the individual will persist when encountering barriers; and level of confidence in attempting the behavior.²²⁶

The behavioral capability and self-efficacy constructs were selected for this research because dental school is a dynamic environment in which students learn from professors, peers, patients, and from their own mastery of skills.²²³ Students learn from and with others in the environment, but learning occurs at the individual level.²²³ Dental students acquire many types of knowledge and skills in dental school, and they develop self-efficacy to perform specific skills and attain goals. They must have high levels of knowledge, skills and self-efficacy to perform the many behaviors necessary to meet the competencies for becoming a general dentist and they must take this knowledge and skills into their practice.

The concept of behavioral intention was included in the conceptual framework to assess dental student's intentions to use communication techniques and caries preventive regimens after they graduate from dental school.⁶⁰ Behavioral intention is an indication of an individual's likelihood of performing a behavior⁶⁰ and it is considered the most proximate predictor of behavior.²⁰⁸ A series of studies by Eccles and colleagues (2012) investigated the relationship between behavioral intention and clinical behaviors among health professionals (doctors, nurses, dentists and pharmacists) and found significant correlations between intention and self-reported behavior.²¹⁴ We chose the TPB behavioral intention construct because we want to assess the dental students' intention to use communication techniques and caries preventive regimens. We assessed behavioral intention instead of 'actual' behavior because dental students are in school and the behaviors they perform are directed by the dental program and we wanted to understand behaviors students intend to adopt when they practice in a clinical setting outside of the dental school.

This research assessed D4 students' behavioral capability, self-efficacy and behavioral intention related to seventeen communication techniques and three caries preventive regimens. We examined whether higher levels of behavioral capability (knowledge and skills) predicted higher levels of self-efficacy and behavioral intention. We also examined whether there were group differences in the outcome measure based on demographic characteristics (Figure 2.1).

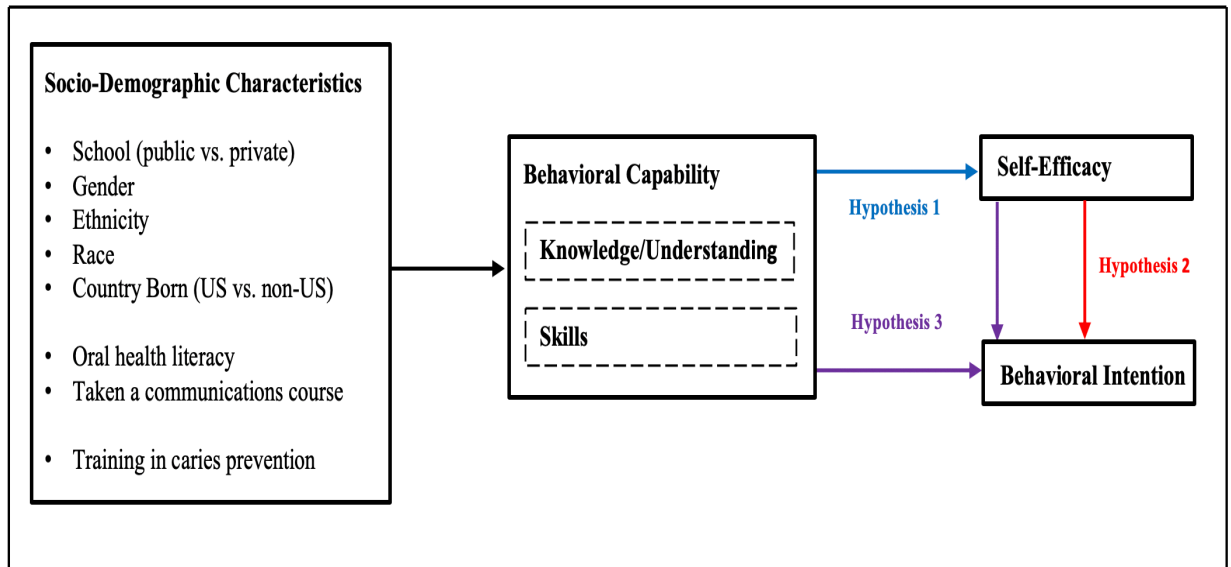


Figure 2.1. Conceptual model of dental students' behavioral capability, self-efficacy and intentions to use selected communication techniques and caries preventive regimens.

Chapter 3: Dental Students Reported Skills, Self-Efficacy and Intention to Use Selected Communication Techniques: A National Survey

Purpose/Objectives: The purpose of this national study was to assess fourth-year dental students about what is taught in their dental school relating to communication techniques shown to improve patient understanding and three caries preventive regimens.

Methods: This 2018 cross-sectional study used a 34-item online survey to assess students' behavioral capability, self-efficacy and behavioral intention related to seventeen communication techniques and three caries preventive regimens. The survey link was sent to 6,061 students; 242 finished it (4.0 percent response rate). Statistical analyses included descriptive statistics; Analysis of Variance to examine associations between demographic variables and behavioral capability, self-efficacy and behavioral intention; and logistic regression to analyze associations between the independent variables behavioral capability and self-efficacy and the dependent variable behavioral intention. The level of significance was set at $p < 0.05$ for all analyses.

Results: Eighty-six percent of students indicated they had received communication skills education and training; 66.1 percent reported being evaluated on these techniques; 21.9 percent reported having a communications course in dental school; and 26.0 percent reported communications lectures were integrated in courses in the dental school curricula. Students who reported higher behavioral capability were 5.5

times as likely to report higher self-efficacy than those who reported lower behavioral capability, $p < .01$; those who reported higher self-efficacy were 9.2 times as likely to report higher behavioral intention than those who reported lower self-efficacy, $p < .01$.

Conclusions: Results indicate many students need additional education and training to increase knowledge, skills, self-efficacy and behavioral intention related to communication skills. Findings from this assessment can help inform curricula development, implementation and board examinations.

Keywords: dental education, dental students, health literacy, dental student assessment, clinical communication

INTRODUCTION

The American Dental Association (ADA) recognizes low health literacy as a potential barrier to the prevention, diagnosis and treatment of oral diseases and in 2006 it adopted resolutions to encourage dental education programs to provide communication and interpersonal skills training.¹ To increase health literacy in dentistry, the ADA's Council on Access, Prevention and Interprofessional Relations and its National Advisory Committee on Health Literacy in Dentistry (NACHLD) developed a strategic plan in 2009 that encouraged education and training about health literacy, including effective communication, in dental practice.² Also in 2009, the Commission on Dental Accreditation (CODA) developed competencies for graduating dentists that included communication/interpersonal skills because "clear, accurate and effective communication is an essential skill for dental practice."^{3(p454)}

Clear and effective communication is critical to delivering quality dental care to all patients, especially those who have low health literacy.³ Low health literacy creates barriers to accessing and understanding health information and services and impedes the ability to take actions to protect and promote health.⁴ Dental providers can decrease the demands the health care system places on patients by taking a "health literacy universal precautions" approach to providing care, services and information.^{5(p1)} Using this approach, providers communicate in a clear and concise manner using plain language, confirming patient understanding and using forms and educational materials designed for low literacy audiences. A universal precautions approach is necessary because providers do not always know who has low health literacy;⁶ many patients do

not admit they have problems understanding health information or instructions because they are ashamed;⁷ some patients, particularly those with low health literacy, are less likely to ask their provider questions because they do not know what to ask;⁷ and providers do not always confirm patients' understanding of the health information or instructions they have given.^{8,9} It is important for dentists to confirm patient understanding because less than half of patients correctly recall instructions or recommended treatment from an office visit.¹⁰

Effective provider communication can reduce barriers to care by helping patients understand health information, health conditions and treatment options, which supports the patients' ability to engage with their provider, make informed decisions and take appropriate actions to maintain health.^{4,11} Effective dentist-patient communication is associated with regular dental care and improved adherence to treatment plans;^{12,13} decreased anxiety;¹⁴ and higher levels of self-rated oral health.¹⁵ It also is associated with higher perceived levels of provider competence,^{14,16,17} higher patient satisfaction,^{18,19} and reduced risk of malpractice claims.¹² Good communication skills allow the provider to ask questions, listen, respond to patient concerns, demonstrate empathy, and provide health information and guidance at a level the patient can understand.^{12,13} Effective dentist-patient communication is associated with higher levels of patient oral health literacy.^{15,20}

For decades both dental and public health organizations have recommended changes to the dental school curricula to prepare students to serve an increasingly diverse patient population.^{1,20-24} Some changes were based on the need for dental providers to effectively communicate with patients

from diverse educational, cultural and economic backgrounds, and those who have differing beliefs and communication styles.^{20,21,24} Other changes recognized the need for dental providers to communicate effectively with individuals who have differing levels of health literacy.²⁵ A patient's level of health literacy affects their: ability to understand their oral health status and prescribed treatment plan; capacity to understand and develop skills to adopt oral self-care behaviors; ability to communicate their health history and ask questions when they do not understand; and skills to navigate the health care system.⁴

There is limited information about the approaches dental schools have taken to incorporate the communications/interpersonal skills competency into their curricula.^{26–33} Recent studies found a lack of standardized practices in teaching and evaluating communication skills compared with technical dental skills.^{33,34} To explore what is taught and practiced in U.S. dental schools related to seventeen recommended communication techniques and three caries preventive regimens, the NACHLD, ADA Council on Advocacy for Access and Prevention (CAAP) conducted a national survey of fourth-year dental (D4) students.

MATERIALS AND METHODS

The NACHLD, ADA Council on Advocacy for Access and Prevention approved the study, the ADA Health Policy Institute administered the survey and we assisted with questionnaire design and analyzed the data. This research was exempted from review by the University of Maryland Institutional Review Board.

This manuscript presents results about the communication techniques.

Theoretical Framework

The foundation of our research is based on constructs from two behavioral theories - Social Cognitive Theory (SCT) and the Theory of Planned Behavior (TPB). We selected these theories because they have been used for course development, teaching and student evaluation in medical education and in a few studies that evaluated behavior change in medical and dental providers.^{23,35-37} We measured two SCT constructs – Behavioral Capability and Self-Efficacy and one TPB construct - Behavioral Intention because of their predictive validity.³⁸⁻⁴⁰ In this study, behavioral capability is the knowledge of and skills to use seventeen communication techniques;³⁸ self-efficacy is the confidence to use the techniques;³⁹ and behavioral intention indicates the likelihood of performing a behavior⁴⁰ – using the communication techniques with patients after graduating from dental school. We examined relationships between behavioral capability, self-efficacy, and behavioral intention. Our model predicted that higher levels of behavioral capability predicted higher levels of both self-efficacy and behavioral intention, and higher levels of self-efficacy predicted higher levels of behavioral intention (Figure 3.1).

Instrument Development

We developed a 34-item survey to assess students' knowledge, skills, self-efficacy and intention to use seventeen communication techniques and three caries preventive regimens. The survey instrument was adapted from a national survey of

general dentists that assessed routine use of eighteen communication techniques shown to promote patient understanding.⁸ The survey also was informed by studies of Maryland health care providers' use of these communication techniques and caries preventive regimens.^{9,41–43}

We drafted the survey in May and June 2017 and seven D4 students reviewed a Microsoft Word version. Students provided feedback on question clarity, survey flow, formatting and the time required to complete the survey. We incorporated their feedback and refined the survey based on comments from the first author's dissertation committee and the CAAP. Staff from the CAAP created the online version of the survey using Qualtrics XM and ADA's Health Policy Institute (HPI) staff tested the survey.⁴⁴ The CAAP and the ADA/CODA/ADEA Joint Advisory Committee on Dental Education Information (ACDEI) reviewed the survey and provided comments that were incorporated.

Sample and Data Collection

HPI obtained D4 student email addresses (n=6,123) from the American Student Dental Association (ASDA). The ASDA reports 95 percent of students who attend the 66 U.S. dental schools are members of their organization (personal communication). In July 2018, the CAAP staff sent students an email that explained the study purpose and included a link to the confidential survey. The survey was open for eight weeks. Three follow-up reminders were sent: one week after the survey opened; three weeks later; and one week later. HPI staff provided us a de-identified data file for analysis in October 2018.

To increase participation, the CAAP sent an email to all dental school deans to make them aware of the survey and to ask them to encourage their students to complete the survey. They sent a letter to senior management at the American Dental Education Association (ADEA) requesting they encourage faculty to support the survey. Also, the CAAP offered a raffle of five \$100 Amazon gift cards to students who completed the survey and elected to be in a drawing. Five students were selected in October 2018.

Measures

Students were asked about their knowledge/understanding, skills, self-efficacy and behavioral intention related to each of seventeen communication techniques. The primary outcome measure, behavioral intention to use the communication techniques, had response options of ‘not at all likely’ = 1, ‘somewhat likely’ = 2 and ‘extremely likely’ = 3. The 17 items were summed to create the behavioral intention index, with values ranging from 17-51. The independent variables, knowledge/understanding of the communication techniques and skills to use the techniques, had response options of ‘yes’ = 1 or ‘no’ = 0, with 17 items each. The 34 knowledge/understanding and skills items were summed to create the behavioral capability index; values ranged from 0-34. The independent variable self-efficacy had response options of ‘not at all confident’ = 1, ‘somewhat confident’ = 2 and ‘extremely confident’ = 3. The 17 items were summed to create the self-efficacy index; values ranged from 17-51. For logistic regression analysis, we categorized the scores of each of the indices into three approximately equal groups to represent low, medium and high scores using SPSS.

The low and medium groups were combined and used as the reference group in the logistic regression analysis to compare scores of the low/medium group to the group with the highest scores.

We asked students if they had received communication skills education and training in their dental program ('yes' or 'no'), if they had been evaluated on the use of any of the seventeen communication techniques ('yes' or 'no'), where were they evaluated ('class only', 'clinic only', or 'class and clinic') and the type of communications courses they had taken ('undergraduate course', 'dental school course' or 'lectures on communications integrated in dental school curricula'). We asked about the types of interpersonal skills taught in their dental school, the educational methods used and their greatest challenge communicating with patients who have difficulty understanding them. Finally, we asked about their plans for the first year after graduation from dental school. Demographic variables included their type of school ('public' or 'private'), the country they were born in ('U.S.' or Non-U.S.), gender, ethnicity, race and if they had heard the term 'oral health literacy' ('yes' or 'no').

Statistical Analysis.

The data were analyzed using IBM SPSS Statistics version 25 (Armonk, N.Y.). The statistical analyses included distributions (frequencies and percentages) of student characteristics, types of interpersonal skills taught in school, methods used in the clinic to support patients, and behavioral capability, self-efficacy and behavioral intention related to the communication techniques. Associations between all

demographic variables and the mean number of communication techniques were examined using Analysis of Variance (ANOVA). In the ANOVA, we used the selected socio-demographic variables as independent variables and the mean number of communication techniques for self-efficacy and behavioral intention as the dependent variables.

To analyze the associations between the independent variables behavioral capability and self-efficacy and the dependent variable behavioral intention we used logistic regression. We ran four regression models to assess the following: Does higher behavioral capability predict higher self-efficacy; does higher self-efficacy predict higher behavioral intention; does higher behavioral capability predict higher behavioral intention; and when both higher behavioral capability and higher self-efficacy are included in the model, do both continue to independently predict behavioral intention? The regression models included socio-demographic variables that were significant in the bivariate analysis and were removed if they were no longer significant in adjusted models. We also compared characteristics of respondents to their cohort who started their undergraduate dental program in 2015-2016 to assess response bias. The level of significance was set at $p < 0.05$ for all analyses.

RESULTS

Sample Description

Of the 6,123 email addresses, sixty-one were invalid and one was a duplicate resulting in a sampling frame of 6,061 students. Of these, 344 respondents started the

survey and 242 submitted it for a response rate of 4.0 percent. All respondents had complete data for the independent and dependent variables, but a few were missing data for descriptive or background variables as noted in the tables. The majority of students attended a private dental school (59.5%), identified as female (61.2%) and white (61.6%), were born in the U.S. (73.1%), and had heard of health literacy or oral health literacy (91.7%). After graduation, over forty percent plan to work as a private practice dentist; approximately forty percent plan to enroll in a residency program in a dental specialty or enter a general practice residency/advanced education in general dentistry program; and ten percent plan to practice in a public health facility such as a Federally Qualified Health Center (FQHC) or Indian Health Center clinic (Table 3.1). Respondents differed significantly from their 2015-2016 cohort entering dental school in that they more likely be female (61.2% vs 48.8%, $p<.01$), white (61.6% vs. 54.4%, $p=.03$) and attend a private dental school (59.5% vs. 48.7%, $p<.01$).⁴⁵ They differed from 2019 graduates in that fewer planned to enter private practice (48.0% vs. 42.6%) and more than twice as many planned to practice at a FQHC (3.5% vs. 8.7%).⁴⁶

When asked about their education and training related to the seventeen communication techniques, 86.0 percent responded they had received such training, but only 66.1 percent reported being evaluated on these techniques. Fifty-nine percent indicated they had ever taken a communications course; of these, 21.9 percent reported taking a communications course in dental school and 26.0 percent reported having lectures on communications that were integrated in courses in the dental school curricula. Slightly more than half (51.7%) indicated a communication

skills course should be taught in dental school (Table 3.2).

We asked students about the types of interpersonal skills taught in their dental school. Eighty-six percent reported their program taught them to encourage patients to ask questions and seventy-four percent reported being taught to ask patients to explain their understanding of their dental problems. With regard to the educational methods used in their program, eighty-four percent reported they had lectures on provider-patient communication, but less than seventy-percent indicated that standardized patients/actors were used for training (64.0%) or that written scripts were used to educate patients (69.8%) (Table 3.2). When asked about their greatest challenge with a patient who has trouble understanding them, the most frequent responses were ‘I do not speak the patient’s language and I do not know what to do’ (20.7%), ‘I need more experience explaining information in plain language’ (17.8%), ‘the patient does not follow my instructions, regardless of how well I explain them’ (16.9%) and ‘I cannot provide information more simply than I already do’ (9.9%).

Descriptive Results for Communication Techniques

With regard to having knowledge/understanding of each of the communication techniques, affirmative responses ranged from 98.3 to 55.8 percent; eight techniques had a response rate of ninety percent or higher. For skills to use each of the communication techniques, affirmative responses ranged from 96.3 to 59.9 percent and six techniques had a response of ninety percent or higher. When asked about their self-efficacy to use the communication techniques with patients,

responses of ‘extremely confident’ ranged from 79.8 to 52.9 percent; seven techniques had a response rate of at least seventy percent. For the primary outcome measure behavioral intention to use each of the techniques with patients after graduation, responses of ‘extremely likely’ ranged from 83.1 to 37.6 percent, with five techniques having a response rate of seventy percent or higher (Table 3.3).

Variables Associated with Self-Efficacy and Behavioral Intention to use Communication Techniques

In the bivariate analysis, none of the seven socio-demographic variables were significantly associated with self-efficacy to use the communication techniques (Table 3.4). For our primary outcome variable behavioral intention, only country of birth was significantly associated with intention to use the seventeen techniques. Respondents born in the U.S. reported greater behavioral intention to use the seventeen communication techniques (mean 2.59) than those not born in the U.S. (mean 2.42), $p=.025$.

To examine the associations between our key variables (behavioral capability, self-efficacy and behavioral intention), we ran four logistic regression models. The only significant variable from the bivariate analysis, ‘country of birth’, was included but was nonsignificant in all models and removed from the final regression models. Since the difference was extremely small and not of practical significance in bivariate analyses, we were not surprised this variable was not significant in the adjusted models. In Model 1, those who reported higher behavioral capability were 5.5 times as likely to have higher self-efficacy than those who

reported lower behavioral capability, 95% CI (3.10, 9.80), $p < .01$. In Model 2, those who reported higher self-efficacy were 9.2 times as likely to have higher behavioral intention than those who reported lower self-efficacy, 95% CI (4.10, 16.96), $p < .01$. In Model 3, those who reported higher behavioral capability were 3.1 times as likely to have higher behavioral intention than those who reported lower behavioral capability, 95% CI (1.75, 5.34), $p < .01$. In Model 4, behavioral capability was not significant ($p = 0.10$) when self-efficacy was entered into the model (Table 3.5), and those who reported higher self-efficacy were 7.6 times as likely to have higher behavioral intention than those with lower self-efficacy, 95% CI (4.02, 14.55), $p < .01$.

DISCUSSION

For dentists to have effective provider-patient communication skills, their undergraduate dental education must include communication skills education and training. Importantly, dental schools should evaluate students on these skills to ensure they meet the CODA communication/interpersonal skills competency.³ Our findings suggest some schools have implemented courses to support this competency. However, there is cause for concern about the emphasis placed on communication skills in some school curricula with only a quarter of students reporting they had lectures on communications integrated in other courses and fewer (21.9%) reporting they had taken a communications course.

Communication skills are recognized as an essential skill for delivering quality dental care,³ and undergraduate dental programs should emphasize the

importance of these skills in their curricula. One approach to emphasizing these skills is to have a standalone communications course that covers the depth and breadth of this important skill. Based on respondent feedback, some schools have a standalone course, while other schools incorporate lectures on communication skills within other courses in the curricula. We argue the later approach may not place enough emphasis on communication skills training. Responses to the question about the greatest challenge in communicating with a patient who has trouble understanding them suggests more training is needed. Some students reported they need more experience explaining information in plain language. Others responded they cannot provide information more simply than they already do or patients do not follow their instructions regardless of how well they explain things. Students will encounter such challenges when they begin practicing, so schools must ensure students have the skills to effectively communicate with patients.

Another indicator of the need for greater emphasis on communication skills training was students' responses to questions about their self-efficacy and behavioral intention to use the communication techniques. We interpret the self-efficacy responses to indicate students' confidence in using the communication techniques. For the 'extremely confident' response option for self-efficacy, only seven techniques had a response rate of over 70 percent. The highest percentage was 80 percent, almost twenty points lower than those for the knowledge and skills measures. More disconcerting was the low percentage of students who reported behavioral intention of 'extremely likely' to use the communication techniques with patients after graduation; fourteen of seventeen techniques had response rates of less

than seventy-five percent. This may indicate students do not value the techniques or do not think they are important to their future practice. Also, only two-thirds of students reported they had been evaluated on these communication techniques. If students are not evaluated on a skill, they may deem it less important than skills they are evaluated on. Thus, training should include evaluation in the classroom and the clinic. On a positive note, respondents with higher levels of behavioral capability were more likely to have higher levels of self-efficacy and those with higher self-efficacy were more likely to have higher levels of behavioral intention. Schools could explore using these constructs when revising or developing communication skills courses.

Our findings are in line with results from the national and Maryland surveys of general dentists. The previous studies found dentists routinely used a low percentage of communication techniques, and our study found a low percentage of students who had high levels of self-efficacy and behavioral intention to use the techniques.^{8,9} In the previous studies the four communication techniques dentists reported using most frequently were the same four techniques associated with the highest level of behavioral intention in our survey – use simple language, use models or x-rays to explain, speak slowly, and hand out printed materials. A key difference between the previous surveys and this survey is the primary outcome measure. The previous surveys measured dentists' routine use of communication techniques and our primary outcome measure was students' behavioral intention to use these techniques. The outcome measures are different, but we think our findings provide insight into students' behavioral intention, which is known to predict future

behavior.^{40,47}

The current communication skills competencies are ten years old and our findings suggest some schools are not adequately educating, training and evaluating students with regard to these competencies. CODA is the accrediting body for U.S. dental schools; it could take actions to require greater emphasis on communication skills in dental education. For example, the CODA team responsible for accrediting dental schools could include members who have expertise in communication skills. These members could better elucidate current approaches to teaching these competencies and make recommendations to curricula and board examinations such that greater emphasis is placed on communication skills. Second, few dental schools have communications or behavioral scientists on their faculty, which impacts curricula content and focus. Hiring faculty members with these skills would provide a voice for these skills in curricula design and provide accountability for implementing CODA communication skills competencies. Third, CODA accrediting teams have more dentists than dental hygienists. Most dentists view dental care through a ‘treatment lens’ versus a ‘prevention lens’. Therefore, adding more dental hygienists, who are trained in prevention and patient education, could help drive the curricula towards greater emphasis on communication skills, patient education and prevention.

While not assessed in this study, external factors also have strong influence on dental education practices. Dental schools operate like private dental practices in that they must make money to stay in business. Time spent communicating with patients to educate them about how to care for their oral health is often not reimbursed. Dental education is no different than any other business in that more highly compensated

practices are more likely to be performed. Compensation practices can send the message to students that communication skills are not as important as other clinical skills. Thus, students may leave their undergraduate dental education not valuing these skills or believing they are important to their future practices.

There are several steps dental schools can take to place greater emphasis on communication skills in their program. Schools could conduct a health literacy environmental scan focused on communication skills and take steps to become a health literate health care organization.^{48,49} Health literate health organizations act to lower barriers to care for patients by using health literacy strategies in interpersonal communication; design content that is easy to understand and act on; and provide easy access to health information and services.⁴⁸ Conducting a scan could help schools assess faculty and staff education and training related to communication skills. A curricula review would assess the amount of time allocated to teaching communication skills and the context in which skills are taught. Finally, schools could adopt teaching methods that standardize patient interactions using written scripts for patient education and standardized patients/actors to allow students to practice provider-patient communications.⁵⁰

Study Limitations and Future Research

Our survey response rate was low and not all dental schools were represented in the study. Also, respondents may have attended a dental school that emphasized communication skills in their curriculum making them more interested in the topic and more likely to respond to the survey. Our study used self-report data making it

possible students responded in a way they thought was more socially acceptable or expected. Also, our survey was lengthy and placed a burden on study participants, which may have caused a quarter of respondents to not complete the survey. Finally, measures, while based on behavioral theory were exploratory in nature, had not been previously validated and were highly skewed; future studies should explore using a 5- or 7-point scale to increase variability in responses. Future research should also examine dental school curricula and interview appropriate school staff for a more complete view of how communication skills are taught in dental schools.

CONCLUSIONS

Communication skills are critical to delivering quality patient care. These skills can affect patient engagement and oral health literacy, and thus should be emphasized in undergraduate dental education. Overall, our results indicate some students need additional education and training related to communication skills. Findings from this assessment can be used as a basis for examining individual dental school programs and can help inform curricula development, implementation and board examinations.

REFERENCES FOR CHAPTER 3

1. American Dental Association. ADA Resolution 14H-2006. Available at: <https://www.dentalcare.com/en-us/professional-education/ce-courses/ce335/the-dental-profession-s-response>. Published 2006. Accessed February 3, 2020.
2. American Dental Association C on AP and IR. *Health Literacy in Dentistry Action Plan 2010-2015*. Chicago, IL; 2009.
3. Commission on Dental Accreditation. Accreditation Standards for Dental Education Programs. Available at: www.ada.org/coda. Published 2019. Accessed February 2, 2020.
4. Institute of Medicine, Committee on Health Literacy, & Nielsen-Bohlman L. *Health Literacy: A Prescription to End Confusion*. Washington, DC 2001: The National Academies Press; 2004.
5. DeWalt D, Callahan L, Hawk V, et al. Health Literacy Universal Precautions Toolkit. AHRQ Publication. Available at: <https://www.ahrq.gov/professionals/quality-patient-safety/quality-resources/tools/literacy-toolkit/index.html>. Published 2010. Accessed February 3, 2020.
6. Davis T. Health Literacy: Hidden Barriers and Practical Strategies. Agency for Healthcare Research & Quality. Available at: <http://www.ahrq.gov/professionals/quality-patient-safety/quality-resources/tools/literacy-toolkit/tool3a/index.html>. Published 2015. Accessed February 3, 2020.
7. Katz MG, Jacobson TA, Veledar E, Kripalani S. Patient literacy and question-asking behavior during the medical encounter: A mixed-methods analysis. *J Gen Intern Med*. 2007;22(6):782-786.
8. Rozier RG, Horowitz AM, Podschun G. Dentist-patient communication techniques used in the United States: The results of a national survey. *J Am Dent Assoc*. 2011;142(5):518-530.
9. Maybury C, Horowitz AM, Wang MQ, Kleinman DV. Use of communication techniques by Maryland dentists. *J Am Dent Assoc*. 2013;144(12):1386-1396.
10. Laws MB, Lee Y, Taubin T, Rogers WH, Wilson IB. Factors associated with patient recall of key information in ambulatory specialty care visits: Results of an innovative methodology. *PLoS One*. 2018;13(2):1-13.
11. National Institute of Dental and Craniofacial Research. The invisible barrier:

- literacy and its relationship with oral health. A report of a workgroup sponsored by the National Institute of Dental and Craniofacial Research, National Institute of Health, U.S. Public Health Service, Department of Health and Huma. *J Public Health Dent*. 2005;65(3):174-182.
12. Hannah A, Millichamp CJ, Ayers KMS. A communication skills course for undergraduate dental students. *J Dent Educ*. 2004;68(9):970-977.
 13. Yoshida T, Milgrom P, Coldwell S. How do U.S. and Canadian dental schools teach interpersonal communication skills? *J Dent Educ*. 2002;66(11):1281-1288.
 14. Armfield JM, Heaton LJ. Management of fear and anxiety in the dental clinic: A review. *Aust Dent J*. 2013;58(4):390-407.
 15. Guo Y, Logan HL, Dodd VJ, Muller KE, Marks JG, Riley JL. Health literacy: A pathway to better oral health. *Am J Public Health*. 2014;104(7):85-91.
 16. Anderson CN, Noar SM, Rogers BD. The persuasive power of oral health promotion messages: A Theory of Planned Behavior approach to dental checkups among young adults. *Health Commun*. 2013;28(3):304-313.
 17. Hamilton MA, Rouse RA, Rouse J. Dentist communication and patient utilization of dental services: Anxiety inhibition and competence enhancement effects. *Health Commun*. 1994;6(2):137-158.
 18. Carey J, Madill A, Manogue M. Communications skills in dental education: A systematic research review. *Eur J Dent Educ*. 2010;14(2):69-78.
 19. Sondell K, Soderfeldt B, Palmqvist S. Dentist-patient communication and patient satisfaction in prosthetic dentistry. *Int J Prosthodont*. 2002;15(1):28-37.
 20. Institute of Medicine and National Research Council. *Improving Access to Oral Health Care for Vulnerable and Underserved Populations*. Washington, DC; 2011.
 21. Institute of Medicine. *Dental Education at the Crossroads: Challenges and Change*. (Field MJ, ed.). Washington, DC: The National Academies Press; 1995.
 22. Institute of Medicine. *Toward Health Equity and Patient-Centeredness: Integrating Health Literacy, Disparities Reduction, and Quality Improvement: Workshop Summary*. Washington, DC: The National Academies Press; 2009.
 23. Ramos-Gomez FJ, Silva DRP, Law CS, Pizzitola RL, John B, Crall JJ. Creating a new generation of pediatric dentists: a paradigm shift in training. *J*

Dent Educ. 2014;78(12):1593-1603.

24. Ayn C, Robinson L, Nason A, Lovas J. Determining recommendations for improvement of communication skills training in dental education - scoping review. *J Dent Educ.* 2017;81(4):479-488.
25. U.S. Department of Health and Human Services. *A National Call To Action to Promote Oral Health: A Public-Private Partnership*. Rockville, MD; 2003.
26. Haden NK, Hendricson WD, Kassebaum DK, et al. Curriculum change in dental education, 2003-09. *J Dent Educ.* 2010;74(5):539-557.
27. Laurence B, Bertera EM, Feimster T, Hollander R, Stroman C. Adaptation of the communication skills attitude scale (CSAS) to dental students. *J Dent Educ.* 2012;76(12):1629-1638.
28. Oakley M, Horvath Z, Weinberg SM, Bhatt J, Spallek H. Comparison of e-mail communication skills among first- and fourth-year dental students. *J Dent Educ.* 2013;77(11):1413-1424.
29. McKenzie CT. Dental student attitudes towards communication skills instruction and clinical application. *J Dent Educ.* 2014;78(10):1388-1396.
30. McKenzie CT. Instructor and dental student perceptions of clinical communication skills via structured assessments. *J Dent Educ.* 2016;80(5):563-568.
31. Aalboe JA, Schumacher MM. An instrument to measure dental students' communication skills with patients in six specific circumstances: An exploratory factor analysis. *J Dent Educ.* 2016;80(1):58-64.
32. Wener ME, Schönwetter DJ, Mazurat N. Developing new dental communication skills assessment tools by including patients and other stakeholders. *J Dent Educ.* 2011;75(12):1527-1541.
33. Broder HL, Janal M, Mitnick DM, Rodriguez JY, Sisco L. Communication skills in dental students: New data regarding retention and generalization of training effects. *J Dent Educ.* 2015;79(8):940-948.
34. Cannick GF, Horowitz AM, Garr DR, et al. Use of the OSCE to evaluate brief communication skills training for dental students. *J Dent Educ.* 2007;71(9):1203-1209.
35. Oxman A, Thomson M, Davis D, Haynes B. No magic bullets: a systematic review of 102 trials of interventions to improve professional practice. *Can Med Assoc J.* 1995;153(10):1423-1431.

36. Eccles MP, Grimshaw JM, MacLennan G, et al. Explaining clinical behaviors using multiple theoretical models. *Implement Sci.* 2012;7(1):99.
37. Bonetti D, Johnston M, Clarkson J, Turner S. Applying multiple models to predict clinicians' behavioural intention and objective behaviour when managing children's teeth. *Psychol Health.* 2009;24(7):843-860.
38. Bandura A. *Social Foundations of Thought and Action. A Social Cognitive Theory.* Englewood Cliffs, NJ: Prentice-Hall; 1986.
39. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. *Psychol Rev.* 1977;84(2):191-215.
40. Fishbein M, Ajzen I. *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research.* Reading, MA: Addison-Wesley; 1975.
41. Horowitz AM, Clovis JC, Wang MQ, Kleinman DV. Use of recommended communication techniques by Maryland dental hygienists. *J Dent Hyg.* 2013;87(4):212-223.
42. Weatherspoon J, Horowitz AM, Kleinman DV, Wang MQ. The use of recommended communication techniques by Maryland family physicians and pediatricians. *PLoS One.* 2015;10(4):1-16.
43. Koo LW, Horowitz AM, Radice S, Wang MQ, Kleinman DV. Nurse practitioners' use of communication techniques: Results of a Maryland oral health literacy survey. *PLoS One.* 2016;11(1):1-16.
44. Qualtrics XM [Computer Software]. 2019. <https://www.qualtrics.com/>.
45. American Dental Association. 2016-17 Survey of Dental Education. Available at: <http://www.ada.org/en/science-research/health-policy-institute/data-center/dental-education>. Published 2017. Accessed February 3, 2020.
46. American Dental Education Association. *Snapshot of Dental Education 2019-2020.* Washington DC; 2019. Available at: https://www.adea.org/uploadedFiles/ADEA/Content_Conversion_Final/deansbriefing/2019-20_ADEA_Snapshot_of_Dental_Education.pdf. Accessed February 03, 2020.
47. Ajzen I. From Intentions to Actions: A Theory of Planned Behavior. In: Kuhl J, Beckman J, eds. Heidelberg: Springer; 1985:11-39.
48. Brach C, Keller D, Hernandez L, et al. *Ten Attributes of Health Literate Health Care Organizations.*; 2012. Available at: <http://iom.edu/~media/Files/Perspectives-Files/2012/Discussion->

Papers/BPH_Ten_HLit_Attributes.pdf. Accessed February 3, 2020.

49. Horowitz AM, Maybury C, Kleinman D V., et al. Health literacy environmental scans of community-based dental clinics in maryland. *Am J Public Health*. 2014;104(8):85-93.
50. McKenzie CT, Tilashalski KR, Peterson DT, White ML. Effectiveness of standardized patient simulations in teaching clinical communication skills to dental students. *J Dent Educ*. 2017;81(10):1179-1186.

Participant Characteristic (n=242)	n (%)
Type of Dental School	
Public	144 (59.5%)
Private	98 (40.5%)
Country of Birth	
US	177 (73.1%)
Not US	65 (26.9%)
Gender	
Female	148 (61.2%)
Male	94 (38.8%)
Ethnicity Hispanic or Latino[†]	
No	219 (90.5%)
Yes	22 (9.1%)
Race	
White	149 (61.6%)
Asian	65 (26.9%)
Black/African American	10 (4.1%)
More than one race selected	9 (3.7%)
Race unknown	8 (3.3%)
Native Hawaiian/Pacific Islander	1 (0.4%)
Ever Taken a Communications Course	
Yes	143 (59.1%)
No	99 (40.9%)
Have Heard of Oral Health Literacy	
Yes	222 (91.7%)
No	15 (6.2%)
Don't know/Not sure	5 (2.1%)
Plans after graduation[†]	
Practice as an associate & be employed by another dentist	79 (32.6%)
Practice as an associate in a corporate practice	19 (7.9%)
Practice as a self-employed dentist	5 (2.1%)
Enroll in a residency program in a dental specialty	47 (19.4%)
Enter General Practice Residency/Advanced education general dentistry program	56 (23.1%)
Practice in a community clinic/Federally Qualified Health Center	21 (8.7%)
Practice in an Indian Health Service clinic	4 (1.7%)
Unsure	10 (4.1%)
Plan to pursue an MPH degree/MPH residency	0 (0.0%)
[†] Does not total to 242 due to missing data	

Table 3.1. Demographic characteristics of fourth-year dental students.

Participant communication skills education (n=242)	n (%)
Did your dental program provide communication skills education?	
Yes	208 (86.0%)
No	34 (14.0%)
Did your dental program evaluate on the 17 communication techniques?	
Yes	160 (66.1%)
No	82 (33.9%)
Where were students evaluated on communication skills?	
Classroom & clinic	116 (47.9%)
Classroom only	30 (12.4%)
Clinic only	14 (5.8%)
Question skipped because response of 'No' on previous question	82 (33.9%)
Should a communications skills course be taught in dental school?	
Yes	125 (51.7%)
No/Don't Know	18 (7.5%)
In what year would a communication skills course be most beneficial?	
Second year	82 (33.9%)
Third year	75 (31.0%)
Fourth year	30 (12.4%)
First year	28 (11.6%)
Where should a communication skills course be taught?	
Both lecture and clinic	95 (39.3%)
Lecture only	23 (9.5%)
Clinic only	6 (2.5%)
What types of interpersonal skills are taught in dental school? [†]	
Greet patients warmly	213 (88.0%)
Encourage patients to ask questions	208 (86.0%)
Consistently make eye contact	206 (85.1%)
Sit rather than stand while talking with patients	204 (84.3%)
Ask patients to explain their understanding of their dental problems	179 (74.0%)
Give verbal or written information in multiple languages	165 (68.2%)
Enlist help of patient's family member/friend to promote understanding	132 (54.5%)
Offer to help patients complete forms	105 (43.4%)
Which of these methods are used in your dental school? [†]	
Lectures on provider-patient communication	203 (83.9%)
Interpreters or telephone translation for patients	195 (80.6%)
Written scripts are used to educate patients	169 (69.8%)
Standardized patients/actors are used for training	155 (64.0%)
Patient education materials have been reviewed for readability and suitability	147 (60.7%)
[†] Yes/N' response options for each item	

Table 3.2. Fourth-year dental students' responses to questions about communication skills courses, evaluation and suggestions for communication skills training in dental school.

Communication Techniques by Domain and Item	Knowledge to use		Skills to use		Self-Efficacy to use		Behavioral Intention to use	
	Technique		Technique		Technique		Technique	
	'Yes' ^a	n (%)	'Yes' ^a	n (%)	'Extremely Confident' ^b	n (%)	'Extremely Likely' ^c	n (%)
Interpersonal Communication								
Use simple language	238 (98.3%)	225 (93.0%)	187 (77.3%)	200 (82.6%)				
Speak slowly	235 (97.1%)	228 (94.2%)	190 (78.5%)	189 (78.1%)				
Present no more than 2 to 3 concepts at a time	214 (88.4%)	204 (84.3%)	147 (60.7%)	158 (65.3%)				
Draw pictures or use printed illustrations	211 (87.2%)	199 (82.2%)	162 (66.9%)	161 (66.5%)				
Ask if they would like family member/friend in the discussion	180 (74.4%)	196 (81.0%)	151 (62.4%) [†]	136 (56.2%)				
Teach-back Method								
Ask patients to repeat back information or instructions	234 (96.7%)	223 (92.1%)	148 (61.2%)	144 (59.5%)				
Ask patients what they will do at home to follow instructions	220 (90.9%)	213 (88.0%)	160 (66.1%)	147 (60.7%)				
Assistance								
Read instructions out loud	226 (93.4%)	223 (92.1%)	182 (75.2%)	157 (64.9%)				
Write or print out instructions	219 (90.5%)	219 (90.5%)	191 (78.9%)	177 (73.1%)				
Follow-up by phone to check understanding and adherence	203 (83.9%)	206 (85.1%)	156 (64.5%)	145 (59.9%)				
Underline key points on print materials	202 (83.5%)	205 (84.7%)	183 (75.6%)	155 (64.0%)				
Patient-friendly materials and aids								
Use models or x-rays to explain	237 (97.9%)	233 (96.3%)	193 (79.8%)	202 (83.1%)				
Hand out printed materials	216 (89.3%)	215 (88.8%)	191 (78.9%)	180 (74.4%)				
Use a video or DVD	135 (55.8%)	145 (59.9%)	129 (53.3%)	91 (37.6%)				
Patient-friendly Practice								
Use a translator or interpreter	226 (93.4%)	216 (89.3%)	159 (65.7%)	153 (63.2%)				
Refer patients to Internet/other sources of information	185 (76.4%)	197 (81.4%)	149 (61.6%)	137 (56.6%)				
Ask patients how they learn best	156 (64.5%)	176 (72.2%)	128 (52.9%)	128 (52.9%)				

^a Response options were 'yes' or 'no'

^b Response options were 'Extremely Confident', 'Somewhat Confident', 'Not at All Confident'

^c Response options were 'Extremely Likely', 'Somewhat Likely', 'Not at All Likely'

Table 3.3. Fourth-year dental students' knowledge, skills, self-efficacy and behavioral intention to use seventeen communication techniques (n=242).

Characteristics	Self-Efficacy to use 17 Communication Techniques		Behavioral Intention to use 17 Communication Techniques	
	Mean Score	P-value	Mean Score	P-value
Type of School				
Public	2.63		2.57	
Private	2.65	.65	2.49	.22
Country of Birth				
US	2.65		2.58	
Not US	2.58	.18	2.42	.03
Gender				
Female	2.63		2.58	
Male	2.65	.67	2.53	.73
Ethnicity Hispanic or Latino[†]				
Yes	2.65		2.63	
No	2.64	.71	2.53	.40
Race				
White	2.65		2.54	
Non-white	2.62	.55	2.54	.94
Ever taken a communications course				
Yes	2.67		2.56	
No	2.59	.19	2.51	.41
Heard of Oral Health Literacy				
Yes	2.64		2.56	
No/Don't know	2.55	.26	2.39	.15

Table 3.4. Analysis of variance of socio-demographic variables and self-efficacy and behavioral intention to use seventeen communication techniques (n=242).

	Predictor Variable	Dependent Variable	Odds Ratio	95% CI	P-value
Model 1					
Does higher behavioral capability predict higher self-efficacy to use 17 communication techniques?	Behavioral Capability	Self-Efficacy	5.507	(3.095, 9.799)	<.01
Model 2					
Does higher self-efficacy predict higher behavioral intention to use 17 communication techniques?	Self-Efficacy	Behavioral Intention	9.202	(4.992, 16.960)	<.01
Model 3					
Does higher behavioral capability predict higher behavioral intention to use 17 communication techniques?	Behavioral Capability	Behavioral Intention	3.056	(1.748, 5.342)	<.01
Model 4					
Does higher self-efficacy continue to predict higher behavioral intention to use 17 communication techniques once behavioral capability is included in the model?	Behavioral Capability	Behavioral Intention	1.724	(0.901, 3.297)	.10
	Self-Efficacy		7.646	(4.017, 14.550)	<.01
Number of participants in low/medium (L/M) and High groups for each variable: Behavioral Capability: L/M (n=94), High (n=148); Self-Efficacy: L/M (n=140), High (n=102); Behavioral Intention L/M (n=119), High (n=123)					

Table 3.5. Logistic regression models predicting self-efficacy (Model 1) and behavioral intention (Models 2-4) to use seventeen communication techniques (n=242).

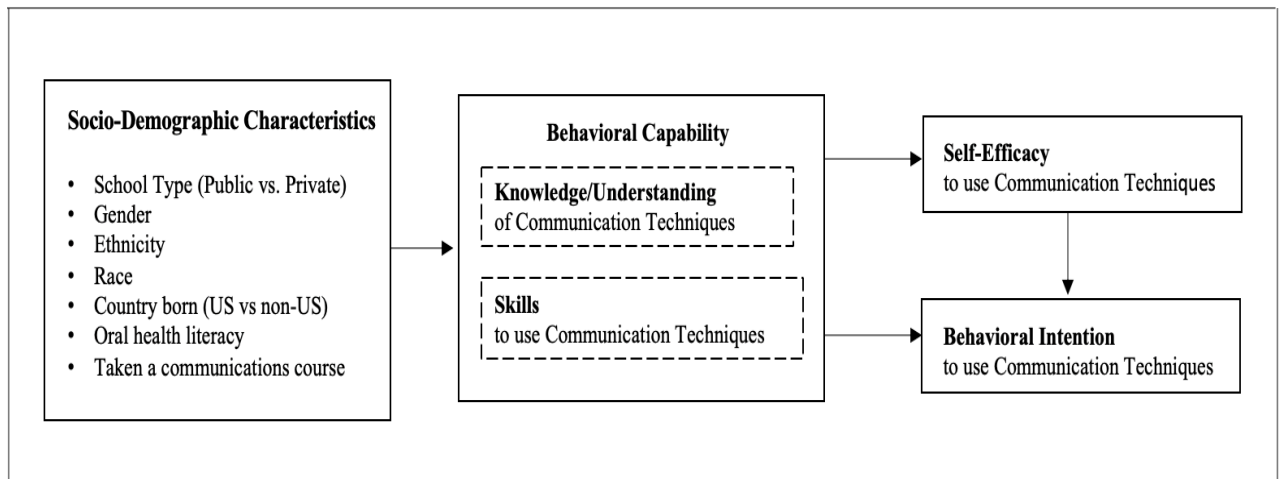


Figure 3.1. Conceptual model of dental students' behavioral capability, self-efficacy and behavioral intention to use selected communication techniques with patients.

Chapter 4: Dental Students Reported Skills, Self-Efficacy and Intention to Use Selected Caries Preventive Regimens: A National Survey

Purpose/Objectives: There is limited information about caries prevention education and training U.S. dental students receive. This 2018 national cross-sectional study surveyed fourth-year dental students to understand what is taught related to three caries preventive regimens – fluoride varnish, pit and fissure sealants and silver diamine fluoride.

Methods: An online survey was used to assess students' behavioral capability, self-efficacy and behavioral intention related to caries preventive regimens. The survey was emailed to 6,061 students; the response rate was 4.0% (n=242). Statistical analyses included descriptive statistics, analysis of variance and logistic regression. Significance was set at $p < 0.05$.

Results: Ninety-seven percent of students reported receiving education and training related to the three caries preventive regimens; 89.3% reported being evaluated on the regimens; and 70.7% reported evaluation in both the classroom and clinic. Students reported having the knowledge, skills, self-efficacy and behavioral intention related to fluoride varnish and dental sealants but reported lower self-efficacy and behavioral intention related to silver diamine fluoride. Students who reported higher behavioral capability were almost 19 times as likely to have higher self-efficacy than those who reported lower behavioral capability, $p < .01$; those who reported higher self-efficacy

were 21.3 times as likely to have higher behavioral intention than those who reported lower self-efficacy, $p < .01$.

Conclusions: Dental schools are responsible for providing foundational education for their students about caries prevention. Schools should review their approach to teaching caries prevention to ensure graduates have the knowledge, skills, self-efficacy and intention to follow current evidence-based guidance on caries prevention.

Keywords: dental education, dental students, dental caries, caries prevention, dental student assessment

INTRODUCTION

Dental caries is largely preventable.¹⁻³ Yet, it is the most common chronic disease in children and adolescents, and most adults have or have had some tooth decay.^{4,5} The prevalence of dental caries has declined over the past twenty-five years in the United States.^{6,7} The decrease can be attributed to widespread exposure to fluoridated water; fluorides such as varnishes, gels and tablets; fluoride toothpaste; greater awareness among the public and health professionals about the importance of oral health and maintaining good oral hygiene; and increased access to care.^{8,9} However, not all groups have experienced this decrease and it remains a significant health problem among individuals with low levels of income, education and health literacy, minority populations and the elderly.^{4-7,9}

To further reduce dental caries in all population groups, experts have called for a shift to a patient-centered approach that is first focused on prevention and when required a conservative approach to treating dental caries.¹⁰⁻¹⁶ The longstanding approach to treating dental caries has been surgical intervention, but this approach does not stop the disease process.^{17,18} Thus, the current evidence-based guidance to prevent and manage dental caries emphasizes individualized risk assessment and care plans to prevent disease; accurate and early detection of caries lesions; and remineralization of non-cavitated lesions to prevent existing lesions from advancing and minimize surgical intervention.^{11,13,16,19} This conservative approach has been shown to reduce dental caries in children and adults.^{13,15,16,19}

Despite the evidence supporting conservative treatment of dental caries, many U.S. dental school curricular courses and student clinical evaluations do not

emphasize this approach.²⁰ It was not until 2019 that ‘caries management’ was included in the competencies specified by the Commission on Dental Accreditation (CODA) Accreditation Standards for Dental Education Programs.²¹ In the past two decades, more emphasis has been placed on caries risk assessment and prevention in dental curricula. Some dental schools have implemented risk assessment protocols, risk-based management, and non-surgical preventive regimens.^{11,19,22–25} Further, members of the American Dental Education Association (ADEA) Section on Cariology developed a competency-based cariology curriculum to specify dental caries risk assessment, detection and management.²⁰ However, there are barriers to increasing emphasis on caries prevention in dental school curricula, especially in clinical teaching. A 2002 survey of U.S. and Canadian dental schools identified barriers to integrating dental caries prevention into clinical teaching.²⁶ Key barriers included: the teaching of prevention was inconsistent and fragmented; some faculty and students did not value prevention; less than a quarter of schools had numerical requirements (hours) in clinical caries prevention; some schools did not emphasize arresting dental caries with non-invasive techniques and licensure exams underemphasized prevention; some faculty did not follow clinical preventive guidelines; some preventive procedures were not reimbursed by insurance; and surgical procedures were reimbursed at a higher rate than time for caries risk assessment and non-surgical management of dental caries.

Dental schools are responsible for providing foundational education for their students about caries prevention and ensuring graduates are proficient in using evidence-based preventive regimens. While there are ongoing and increasing efforts

to emphasize caries prevention in dental school curricula, we wanted to understand the education and training dental students receive related to caries risk assessment and three preventive regimens. Thus, we assessed fourth-year dental (D4) students' knowledge/understanding, skills, self-efficacy and behavioral intention to use fluoride varnish, pit and fissure sealants (dental sealants) and silver diamine fluoride. We selected these three caries preventive regimens because fluorides and dental sealants play a pivotal role in preventing dental caries, and silver diamine fluoride arrests dental caries and reduces the need to perform restorative procedures in hospitals under general anesthesia for very young children.^{2,3,13}

MATERIALS AND METHODS

The National Advisory Committee on Health Literacy in Dentistry (NACHLD), American Dental Association (ADA) Council on Advocacy for Access and Prevention (CAAP) conducted a national cross-sectional survey of fourth-year (D4) students in 2018 to assess education and training related to selected caries preventive regimens and communication techniques. The NACHLD CAAP approved the study, the ADA Health Policy Institute (HPI) administered the survey and we assisted with questionnaire design and analyzed the data. This research was exempted from review by the University of Maryland Institutional Review Board. This manuscript provides findings about the caries preventive regimens.

Instrument Development

We developed a 34-item survey instrument to assess students' knowledge/understanding, skills, self-efficacy and intention related to three caries preventive

regimens and seventeen communication techniques. The survey was adapted from a national survey of general dentists that assessed routine use of communication techniques shown to promote patient understanding²⁷ and studies of Maryland health care providers' use of caries preventive regimens and communication techniques.²⁸⁻³¹

We drafted the survey in May and June 2017. Seven D4 students reviewed a Microsoft Word version of the survey to provide feedback on question clarity, survey flow, formatting and how long it took to complete the survey. We revised the survey based on their feedback and further refined it based on input from the CAAP and the first author's dissertation committee members. Staff from the CAAP created the online survey using Qualtrics XM and ADA's HPI staff tested the survey.³² The CAAP and the ADA/CODA/ADEA Joint Advisory Committee on Dental Education Information (ACDEI) reviewed the survey and provided additional input on survey design.

Sample and Data Collection

The American Student Dental Association (ASDA) provided HPI with D4 student email addresses (n=6,123). The ASDA reports that 95 percent of students attending U.S. dental schools (n=66) are members of their organization (personal communication). The CAAP staff sent students an email that described the study and contained a link to the confidential survey. The survey was executed in July 2018 and closed eight weeks later. The HPI staff provided us with a de-identified data file for analysis in October 2018.

Several steps were taken to increase survey participation. The CAAP sent an email to all dental school deans to inform them of the survey and asked them to encourage their students to complete the survey. The CAAP also sent a letter to senior management at ADEA asking them to encourage faculty to support the survey. Students received three follow-up reminders: one week after the survey opened; three weeks later; and one week later. Finally, the CAAP offered a raffle of five \$100 Amazon gift cards. Names of respondents who completed the survey and elected to be in the drawing were put in a box and CAAP staff drew five names in October 2018.

Theoretical Framework

To ground our research in behavioral theory, study measures were based on two Social Cognitive Theory (SCT) constructs and one Theory of Planned Behavior (TPB) construct. These constructs were chosen because of their predictive validity. (33-35). The SCT constructs are Behavioral Capability and Self-Efficacy. In this study, behavioral capability is the knowledge of and skills to use three caries preventive regimens, and self-efficacy is the confidence to use these preventive regimens.^{33,34} The TPB construct, Behavioral Intention, indicates the likelihood of performing a behavior – to use the caries preventive regimens with patients after graduation – and individuals with high behavioral intention are more likely to perform a behavior than those with low behavioral intention.³⁵ We used our conceptual model to examine relationships between the behavioral capability, self-efficacy and behavioral intention constructs. Our model predicted that higher levels of

behavioral capability predicted higher levels of both self-efficacy and BI, and higher levels of self-efficacy predicted higher levels of behavioral intention (Figure 4.1).

Measures

We asked students about their knowledge/understanding, skills, self-efficacy and behavioral intention related to three caries preventive regimens. The independent variables, knowledge/understanding of the caries preventive regimens and skills to use the caries preventive regimens, had response options of ‘yes’ = 1 or ‘no’ = 0. The knowledge/understanding and skills measures were summed to create the behavioral capability index, with values ranging from 0-6. The independent variable self-efficacy had response options of ‘not at all confident’ = 1, ‘somewhat confident’ = 2 and ‘extremely confident’ = 3. The three items were summed to create the self-efficacy index; values ranged from 3-9. The primary outcome measure, behavioral intention to use the caries preventive regimens, had response options of ‘not at all likely’ = 1, ‘somewhat likely’ = 2 and ‘extremely likely’ = 3. The three items were summed to create the behavioral intention index; values ranged from 3-9. We used SPSS to categorize the scores of each of the indices into three approximately equal groups to represent low, medium and high scores. We combined the low and medium groups together and used it as the reference group in the logistic regression analysis to compare scores of those in the low/medium group to those in the group with the highest scores.

We asked students if their dental program provided education and training in the use of the three caries preventive regimens (‘yes’ or ‘no’), if they had been

evaluated on the regimens ('yes' or 'no'), and where were they evaluated ('class only', 'clinic only', or 'class and clinic'). We asked if they had received education and training on how to assess dental caries risk factors in children ages 0-6 (response options 'yes' or 'no') and which risk factors (n=13) they used to assess caries risk in these children. We also asked about their plans for the first year after graduating from dental school. The demographic variables included the type of school they attended ('public' or 'private'), country they were born in ('U.S.' or 'Non-U.S.'), gender, ethnicity, and race.

Statistical Analysis

The data were analyzed using IBM SPSS Statistics version 25 (Armonk, N.Y.).³⁶ The statistical analyses included distributions (frequencies and percentages) of student characteristics, factors used to assess caries risk in children ages 0-6, and behavioral capability, self-efficacy and behavioral intention related to the caries preventive regimens. Analysis of Variance (ANOVA) was used to examine associations between the socio-demographic characteristics and the mean number of caries preventive regimens using the demographic variables as independent variables and the mean number of caries preventive regimens for self-efficacy and behavioral intention as the dependent variables.

We used logistic regression to analyze the associations between the independent variables behavioral capability and self-efficacy, and the dependent variable behavioral intention. Socio-demographic variables that were significant in the bivariate analysis were included in the regression models, and were removed if

they were no longer significant in adjusted models. We ran four regression models to examine the following: Does higher behavioral capability predict higher self-efficacy; does higher self-efficacy predict higher behavioral intention; does higher behavioral capability predict higher behavioral intention; and when both higher behavioral capability and higher self-efficacy are included in the model, do both continue to independently predict behavioral intention? Finally, to assess response bias, we compared characteristics of study respondents to their cohort who started their undergraduate dental program in 2015-2016.³⁷ The level of significance was set at $p < 0.05$ for all analyses.

RESULTS

Sample Description

The HPI staff received 6,123 email addresses; sixty-one were invalid and one was a duplicate. Thus, the survey was emailed to 6,061 students; 344 started the survey and 242 finished it for a response rate of 4.0 percent. All respondents had complete data for the independent and dependent variables, but a few were missing data for descriptive or background variables as noted in the tables. Most respondents attended a private dental school (59.5%), identified as female (61.2%) and white (61.6%) and were born in the U.S. (73.1%) (Table 4.1). Respondents differed significantly from their 2015-2016 undergraduate dental program cohort in several ways. They were more likely to be female (61.2% vs 48.8%, $p < .01$), white (61.6% vs. 54.4%, $p = .03$) and attend a private dental school (59.5% vs. 48.7%, $p < .01$).³⁷ Compared to their 2019 graduating cohort, more than twice as many reported they

planned to practice at a Federally Qualified Health Center (3.5% vs. 8.7%) and fewer reported they planned to enter private practice (48.0% vs. 42.6%).³⁸

With regard to education and training related to the three caries preventive regimens, 97.1 percent responded they had received such training, 89.3 percent reported being evaluated on these regimens, and 70.7 percent reported being evaluated on the caries preventive regimens in both the classroom and clinic. Ninety-six percent reported training on how to assess caries risk factors in children 0-6 years of age. The most frequently assessed risk factors were fluoride exposure (94.6%), consumption of sugary food or drinks (94.6%) and visual or radiographically evident restorations/cavitated carious lesions (91.3%). The risk factors least frequently assessed were eligibility for government programs such as Medicaid (63.2%), salivary flow (61.6%) and the caregiver's level of health literacy (60.3%) (Table 4.2).

Descriptive Results for Caries Preventive Regimens

Respondents reported having greater knowledge/understanding, skills, self-efficacy and behavioral intention related to fluoride varnish and dental sealants than silver diamine fluoride. Almost all respondents indicated having knowledge of fluoride varnish (98.8%) and dental sealants (98.3%), but only 78.9 percent reported knowledge/understanding of silver diamine fluoride. Similarly, students reported having the skills to apply fluoride varnish (100%) and dental sealants (98.3%), but fewer students (64.9%) reported having skills to apply silver diamine fluoride. With regard to self-efficacy, 89.7 percent reported they were 'extremely confident' in their ability to use fluoride varnish and 87.2 percent were 'extremely confident' in

their ability to apply dental sealants, but only 43.0 percent reported that level of confidence for silver diamine fluoride. For the primary outcome measure of behavioral intention to use the regimens with patients after they graduate from dental school, responses for fluoride varnish and dental sealants were similar to those for self-efficacy, with 89.7 percent and 88.0 percent respectively, reporting they were ‘extremely likely’ to use these regimens. However, only 52.9 percent indicated they were ‘extremely likely’ to use silver diamine fluoride (Table 4.3).

Variables Associated with Self-Efficacy and Behavioral Intention to use the Caries Preventive Regimens

In the bivariate analysis, two variables were significantly associated with self-efficacy: attended a private dental school (mean 2.72) versus a public school (mean 2.54), $p=.01$; and received education and training in the three caries preventive regimens (mean 2.63) versus not receiving training (mean 1.92), $p<.01$. The same two variables were significantly associated with behavioral intention (Table 4.4).

We ran four logistic regression models. We included the two variables (born in US and school type) that were significant in the bivariate analysis, but they were nonsignificant in all models and . They were removed from the final regression models. These variables were statistically significant in the bivariate analysis, but the differences were extremely small and not of practical significance. Thus, we were not surprised these variables were not significant in the adjusted models. In Model 1, those who reported higher behavioral capability had 18.7 times the odds of

having higher self-efficacy than those who reported lower behavioral capability, 95% CI (8.43, 41.57), $p < .01$. In Model 2, compared with those who reported lower self-efficacy, those who reported higher self-efficacy had 21.3 times the odds of having higher behavioral intention to use the caries preventive regimens, 95% CI (10.62, 42.92), $p < .01$. For Model 3, those who reported higher behavioral capability had 5 times the odds of having higher behavioral intention than those who reported lower behavioral capability, 95% CI (3.06, 9.57), $p < .01$. Finally, in Model 4, behavioral capability was no longer significant (95% CI (.72, 3.09), $p < .28$), and those who reported higher self-efficacy were 17.5 times as likely to report higher behavioral intention than those who reported lower self-efficacy, 95% CI (8.03, 37.95), $p < .01$ (Table 4.5).

DISCUSSION

For graduating dentists to have the knowledge, understanding and skills to follow the ADA's current guidance for dental caries prevention and management, their undergraduate dental education must emphasize risk assessment, preventive regimens and a conservative approach to treating caries that minimizes surgical intervention. In our study, almost all students (97.1%) reported receiving education and training related to the three caries preventive regimens. This finding is encouraging. However, our results indicate some students need greater emphasis to be placed on teaching and evaluating students on caries prevention. Specifically, some students may not accurately assess their patients' risk for dental caries. Only three of thirteen risk factors – fluoride exposure, consumption of sugary foods/drinks and

visual or radiographically evident restorations/cavitated carious lesions – had a response rate of over 90 percent, meaning over 90 percent of students reported they used these factors to assess dental caries risk in children 0-6 years of age. These risk factors are important when assessing caries risk, but additional factors should be considered.³⁹ For example, 16-18 percent of students indicated they did not assess incipient carious lesions, dental home or the caries experience of the mother/caregiver and almost 40 percent responded that they did not assess salivary flow, caregiver health literacy or eligibility for government programs such as Medicaid or Women, Infants and Children. Children receiving aid from these programs are poor, and we know that children living in poverty have higher rates of dental caries. Using these additional risk factors helps the dentist form a more complete risk profile, identify patients at high risk for dental caries and create individualized care plans that include these effective preventive measures.^{22,40}

It is encouraging that almost all students reported they had knowledge of and the skills to use fluoride varnish and dental sealants and almost 90 percent indicated a high level of self-efficacy and behavioral intention for the two regimens. We interpret these results to indicate students are being taught about these two preventive regimens and they are confident to use these regimens. In contrast, our results indicate students have less exposure to silver diamine fluoride. Only 65 percent of students reported they had the skills to use silver diamine fluoride, and 43 percent reported a high level of confidence to apply silver diamine fluoride. Silver diamine fluoride is a safe, effective and inexpensive treatment to arrest dental caries, especially for very young

patients to prevent the need for general anesthesia and for elderly patients in nursing homes.⁴¹⁻⁴³ Thus, all students should be proficient in using silver diamine fluoride.

With regard to evaluation, almost 90 percent of students reported they were evaluated on these three caries preventive regimens, but only 70 percent reported being evaluated in both the classroom and clinic. All students should be evaluated on these caries preventive regimens to ensure they have the knowledge and skills to use these regimens. If students are not evaluated on a competency such as caries prevention, they may perceive the competency to be less important than competencies they are evaluated on, and they may incorrectly perceive the competency is not essential to clinical practice. Moreover, if students are not evaluated in both classroom and clinic, how can schools be certain students meet the competency?

For dentistry to advance as a profession to a more patient-centered, evidence-based, and conservative approach to treating dental caries, dental schools must teach these skills. There are structural issues that affect how caries prevention is taught and evaluated in dental school. CODA is the accrediting body for U.S. dental schools; it could take actions to require greater emphasis on caries prevention. For example, the CODA team responsible for accrediting dental schools could include members who have expertise in cariology. These members could better elucidate current approaches to teaching these competencies and make recommendations to curricula and board examinations so greater emphasis is placed on these skills. Second, CODA accrediting teams have more dentists than dental hygienists. Most dentists view dental care through a ‘treatment lens’ versus a ‘prevention lens’. Therefore, adding more dental hygienists, who are trained in prevention and patient education, could help

drive the curricula towards greater emphasis caries prevention and conservative approaches to treating dental caries.

External factors also have strong influence on dental education practices. Dental schools like private dental practices must make money to stay in business. Private insurance companies and the Centers for Medicare and Medicaid Services (CMS) reimburse procedures such as placing a crown or major restorations at a higher rate than preventive regimens such as dental sealants and silver diamine fluoride. Dental schools thus prioritize restorative procedures over preventive regimens resulting in more highly compensated practices being performed more often. Compensation practices can send the message to students that caries prevention is not as important as restorative procedures, and students may leave their undergraduate dental education not valuing these regimens or believing they are important to their future practices.

There are several actions schools can take to minimize barriers. First, schools could implement the core curriculum framework in cariology developed by the ADEA Section on Cariology, realizing it will require a long-term commitment to ensure teaching and clinical behavior are aligned to deliver a patient-centered preventive approach to managing dental caries.^{20,23} For the implementation to be successful, faculty and staff must have adequate training and skills to teach caries prevention in accordance with current evidence-based guidelines. It is especially important for all clinical instructors to support and adopt the evidence-based approach because they are responsible for teaching students foundational skills in caries prevention.^{20,46} Another critical factor that must be addressed is compensating clinical

time spent on the diagnosis and non-surgical management of dental caries on parity with surgical time.^{46,47} In addition, students should be evaluated in both the classroom and clinic to ensure they have the clinical skills related to fluoride varnish, dental sealants and silver diamine fluoride. Finally, dental schools might explore how to incorporate behavioral constructs such as self-efficacy and behavioral intention into the caries prevention courses. We know from behavioral research that knowledge alone does not change behavior and self-efficacy plays an important role in adopting a new skill.⁴⁸ It is encouraging that respondents who reported higher levels of behavioral capability were more likely to report higher levels of self-efficacy and those with higher self-efficacy were more likely to report higher levels of behavioral intention.

Study Limitations

Our survey response rate was low and not all dental schools were represented in the study. Respondents may have attended a dental school that placed greater emphasis on caries prevention in their curriculum making students more likely to respond to the survey. Thus, it is likely respondents were not representative of their cohort as they differed demographically from cohort members. The study was adequately powered but the sample was small. A larger sample might have reduced response bias and provided more representative insight into the D4 student population's education related to caries preventive regimens. Further our study used self-report data, and social desirability may have affected responses. Finally, our data were highly skewed and future studies should consider using a 5- or 7-point

scale to increase differentiation in responses. Future studies should review public and private dental school curricula, as we saw slight differences between public and private schools, and conduct in-depth interviews with individuals who provide caries prevention education for a more comprehensive understanding of the teaching and evaluation related to this competency.

CONCLUSIONS

To reduce the prevalence of dental caries, associated costs and associated oral health disparities in the United States, students must leave dental school with the knowledge, skills and self-efficacy to assess caries risk and use a conservative approach to manage and treat dental caries using preventive regimens such as fluoride varnish, dental sealants and silver diamine fluoride. Dental schools are responsible for providing foundational education for their students about caries prevention and they have a responsibility to teach evidence-based regimens such as silver diamine fluoride. Schools should review their curricula and approach to teaching caries prevention so graduating dentists will be able to practice in accordance with the ADA's current evidence-based guidance for caries prevention and management.

REFERENCES FOR CHAPTER 4

1. U.S. Department of Health and Human Services. *Oral Health in America: A Report of the Surgeon General*. Rockville; 2000. h
2. Weyant RJ, Tracy SL, Anselmo T, et al. Topical fluoride for caries prevention. *J Am Dent Assoc*. 2013;144(11):1279-1291.
3. Wright JT, Crall JJ, Fontana M, et al. Evidence-based clinical practice guideline for the use of pit-and-fissure sealants. *J Am Dent Assoc*. 2016;147(8):672-682.e12.
4. Fleming E, Afful J. National Center for Health Statistics. National Health and Nutrition Examination Survey (NHANES): 2015-2016. *NCHS Data Brief*. 2018;(307):1-8.
5. Dye BA, Thornton-evans G, Li X, Iafolla TJ. Dental caries and tooth loss in adults in the United States, 2011–2012. NCHS data brief, no 197. *Natl Cent Heal Stat*. 2015;(197):1-8.
6. Dye BA, Tan S, Smith V, et al. Trends in oral health status: United States, 1988-1994 and 1999-2004. *Vital Heal Stat*. 2007;Series 11(248):1-92.
7. National Center for Health Statistics. *Health, United States, 2016: With Chartbook on Long-Term Trends in Health. Table 60: Untreated Dental Caries, by Selected Characteristics: United States, Selected Years 1988-1994 through 2011-2014*. Hyattsville, MD.; 2017.
8. National Institutes of Health. *Diagnosis and Management of Dental Caries Throughout Life: NIH Consensus Statement*. Bethesda, MD; 2001. Available at: <https://consensus.nih.gov/2001/2001DentalCaries115PDF.pdf>. Accessed February 3, 2020.
9. Vann Jr WF, Lee JY, Baker DW, Divaris K. Oral health literacy among female caregivers: Impact on oral health outcomes in early childhood. *J Dent Res*. 2010;89(12):1395-1400.
10. Tyas MJ, Anusavice KJ, Frencken JE, Mount GJ. Minimal intervention dentistry - A review: FDI Commission Project 1-97. *Int Dent J*. 2000;50(1):1-12.
11. Ismail AI, Tellez M, Pitts NB, et al. Caries management pathways preserve dental tissues and promote oral health. *Community Dent Oral Epidemiol*. 2013;41(1):12-40.
12. Urquhart O, Tampi MP, Pilcher L, et al. Nonrestorative Treatments for Caries:

- Systematic Review and Network Meta-analysis. *J Dent Res*. 2019;98(1):14-26.
13. Slayton RL, Urquhart O, Araujo MWB, et al. Evidence-based clinical practice guideline on nonrestorative treatments for carious lesions: A report from the American Dental Association. *J Am Dent Assoc*. 2018;149(10):837-849.e19.
 14. Pitts NB, Ismail AI, Martignon S, Ekstrand K, Douglas GV V., Longbottom C. *ICCMSTM Quick Reference Guide for Practitioners and Educators*. London, UK; 2014.
 15. Frencken JE, Manton D, Leal S, Gordan V, Eden E. Minimal intervention dentistry (MID) for managing caries - a review: Report of a FDI task group. *Int Dent J*. 2012;62(5):223-243.
 16. Ekstrand KR, Gimenez T, Ferreira FR, Mendes FM, Braga MM. The International Caries Detection and Assessment System - ICDAS: A Systematic Review. *Caries Res*. 2018;52(5):406-419.
 17. Tinanoff N, Douglass J. Clinical decision-making for caries management of primary teeth. *J Dent Educ*. 2001;65(10):1133-1142.
 18. Sheiham A. Impact of dental treatment on the incidence of dental caries in children and adults. *Community Dent Oral Epidemiol*. 1997;25(1):104-112.
 19. Featherstone JDB, Chaffee BW. The Evidence for Caries Management by Risk Assessment (CAMBRA®). *Adv Dent Res*. 2018;29(1):9-14.
 20. Fontana M, Guzmán-Armstrong S, Schenkel AB, et al. Development of a core curriculum framework in cariology for U.S. dental schools. *J Dent Educ*. 2016;80(6):705-720.
 21. Commission on Dental Accreditation. Accreditation Standards for Dental Education Programs. www.ada.org/coda. Published 2019. Accessed February 2, 2020.
 22. Young DA, Featherstone JDB. Caries management by risk assessment. *Community Dent Oral Epidemiol*. 2013;41(1):53-63.
 23. Chaffee BW, Featherstone JDB. Long-term adoption of caries management by risk assessment among dental students in a university clinic. *J Dent Educ*. 2015;79(5):539-547.
 24. Fontana M, Zero D. Bridging the gap in caries management between research and practice through education: the Indiana University experience. *J Dent Educ*. 2007;71(5):579-591.

25. Rechmann P, Chaffee B, Rechmann B, Featherstone J. Caries management by risk assessment: results from a practice-based research network study. *J Calif Dent Assoc.* 2019;47(1):15-24.
26. Brown JP. A new curriculum framework for clinical prevention and population health, with a review of clinical caries prevention teaching in U.S. and Canadian dental schools. *J Dent Educ.* 2007;71(5):572-578.
27. Rozier RG, Horowitz AM, Podschun G. Dentist-patient communication techniques used in the United States: The results of a national survey. *J Am Dent Assoc.* 2011;142(5):518-530.
28. Maybury C, Horowitz AM, Wang MQ, Kleinman DV. Use of communication techniques by Maryland dentists. *J Am Dent Assoc.* 2013;144(12):1386-1396.
29. Koo LW, Horowitz AM, Radice S, Wang MQ, Kleinman DV. Nurse practitioners' use of communication techniques: Results of a Maryland oral health literacy survey. *PLoS One.* 2016;11(1):1-16.
30. Weatherspoon J, Horowitz AM, Kleinman DV, Wang MQ. The use of recommended communication techniques by Maryland family physicians and pediatricians. *PLoS One.* 2015;10(4):1-16.
31. Horowitz AM, Clovis JC, Wang MQ, Kleinman DV. Use of recommended communication techniques by Maryland dental hygienists. *J Dent Hyg.* 2013;87(4):212-223.
32. Qualtrics XM [Computer Software]. 2019. <https://www.qualtrics.com/>.
33. Bandura A. *Social Foundations of Thought and Action. A Social Cognitive Theory.* Englewood Cliffs, NJ: Prentice-Hall; 1986.
34. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. *Psychol Rev.* 1977;84(2):191-215.
35. Fishbein M, Ajzen I. *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research.* Reading, MA: Addison-Wesley; 1975.
36. IBM Corp. IBM SPSS Statistics for Windows, version 25.
37. American Dental Association. 2016-17 Survey of Dental Education. <http://www.ada.org/en/science-research/health-policy-institute/data-center/dental-education>. Published 2017. Accessed December 10, 2017.
38. American Dental Education Association. *Snapshot of Dental Education 2019-2020.* Washington DC; 2019.

https://www.adea.org/uploadedFiles/ADEA/Content_Conversion_Final/deansbriefing/2019-20_ADEA_Snapshot_of_Dental_Education.pdf.

39. American Dental Association. Caries Risk Assessment and Management. <https://www.ada.org/en/member-center/oral-health-topics/caries-risk-assessment-and-management>. Published 2018. Accessed December 29, 2019.
40. Featherstone J. The caries balance: The basis for caries management by risk assessment. *Oral Heal Prev Dent*. 2004;2(Suppl 1):1259-1264.
41. Crystal YO, Marghalani AA, Ureles SD, et al. Use of silver diamine fluoride for dental caries management in children and adolescents, including those with special health care needs. *Pediatr Dent*. 2017;39(5):135-145.
42. Oliveira BH, Cunha-Cruz J, Rajendra A, Niederman R. Controlling caries in exposed root surfaces with silver diamine fluoride: a systematic review with meta-analysis. *J Am Dent Assoc*. 2018;149(8):671-679.
43. Seifo N, Cassie H, Radford JR, Innes NPT. Silver diamine fluoride for managing carious lesions: An umbrella review. *BMC Oral Health*. 2019;19(1):1-10.
44. Riley III J, Gordan V, Rouisse K, McClelland J, Gilbert G. Gender differences in practice patterns for diagnosis and treatment of dental caries: Findings from The Dental PBRN. *J Am Dent Assoc*. 2011;142(14):429-440.
45. Riedy CA, Ly KA, Ybarra V, Milgrom P. An FQHC research network in oral health: enhancing the workforce and reducing disparities. *Public Health Rep*. 2007;122(5):592-601.
46. Tikhonova S, Girard F, Fontana M. Cariology education in Canadian Dental Schools: Where are we? Where do we need to go? *J Dent Educ*. 2018;82(1):39-46.
47. Pitts NB, Mazevet ME, Mayne C, et al. Shaping the future of dental education: caries as a case-study. *Eur J Dent Educ*. 2018;22(March):30-37. doi:10.1111/eje.12345
48. Glanz K, Rimer BK, Lewis FM, eds. *Health Behavior and Health Education: Theory, Research and Practice*. 3rd ed. San Francisco; 2002.

Participant Characteristic (n=242)	n (%)
Type of dental school	
Public	144 (59.5%)
Private	98 (40.5%)
Country of birth	
US	177 (73.1%)
Not US	65 (26.9%)
Gender	
Female	148 (61.2%)
Male	94 (38.8%)
Ethnicity Hispanic or Latino[†]	
No	219 (90.5%)
Yes	22 (9.1%)
Race	
White	149 (61.6%)
Asian	65 (26.9%)
Black/African American	10 (4.1%)
More than one race selected	9 (3.7%)
Race unknown	8 (3.3%)
Native Hawaiian/Pacific Islander	1 (0.4%)
Plans after graduation	
Practice as an associate & be employed by another dentist	79 (32.6%)
Practice as an associate in a corporate practice	19 (7.9%)
Practice as a self-employed dentist	5 (2.1%)
Enroll in a residency program in a dental specialty	47 (19.4%)
Enter General Practice Residency/Advanced education general dentistry program	56 (23.1%)
Practice in a community clinic/Federally Qualified Health Center	21 (8.7%)
Practice in an Indian Health Service clinic	4 (1.7%)
Unsure	10 (4.1%)
Plan to pursue an MPH degree/MPH residency	0 (0.0%)
[†] Does not total to 242 due to missing data	

Table 4.1. Demographic characteristics of fourth-year dental students.

Participant education on caries preventive regimens (n=242)	n(%)
Dental program provided education & training on the three caries preventive regimens	
Yes	235 (97.1%)
No	4 (1.7%)
Dental program evaluated students on the three caries preventive regimens?	
Yes	216 (89.3%)
No	26 (10.7%)
Place evaluation on the three caries preventive regimens occurred	
Classroom & clinic	171 (70.7%)
Clinic only	34 (14.0%)
Classroom only	11 (4.5%)
Received training on how to assess caries risk factors for children 0-6 years of age	
Yes	232 (95.9%)
No	10 (4.1%)
Factors used to assess risk for dental caries in children 0-6 years	
Fluoride exposure (through drinking water, supplements, professional applications, toothpaste)	229 (94.6%)
Sugary food or drinks (including juice, carbonate or non-carbonated soft drinks, energy drinks, medicinal syrups)	229 (94.6%)
Visual or radiographically evident restorations/cavitated carious lesions	221 (91.3%)
Visible plaque	214 (88.4%)
Teeth missing due to caries	207 (85.5%)
Caries experience of the mother, caregiver and/or other siblings	204 (84.3%)
Special health care needs (developmental, physical, medical or mental disabilities that prevent/limit adequate oral health self-care)	200 (82.6%)
Non-cavitated (incipient carious lesions)	199 (82.2%)
Dental home (established patient of record in a dental office)	198 (81.8%)
Dental/orthodontic appliances present (fixed or removable)	196 (81.0%)
Eligible for government programs (WIC, Head Start, Medicaid or SCHIP)	153 (63.2%)
Salivary flow	149 (61.6%)
Caregiver level of health literacy	146 (60.3%)

Table 4.2. Fourth-year dental students' responses to questions about caries prevention courses and evaluation in dental school.

Caries Preventive Regimen			
	Fluoride Varnish	Dental Sealants	Silver Diamine Fluoride
Measures	n (%)	n (%)	n (%)
Knowledge of regimen			
Yes	239 (98.8%)	238 (98.3%)	191 (78.9%)
No	3 (1.2%)	4 (1.7%)	51 (21.1%)
Skills to use regimen			
Yes	242 (100.0%)	238 (98.3%)	157 (64.9%)
No	0 (0.0%)	4 (1.7%)	85 (35.1%)
Self-Efficacy to use regimen			
Extremely Confident	217 (89.7%)	211 (87.2%)	104 (43.0%)
Somewhat Confident	14 (5.8%)	17 (7.0%)	82 (33.9%)
Not at all Confident	14 (5.8%)	14 (5.8%)	55 (22.7%)
Behavioral Intention to use regimen			
Extremely Likely	217 (89.7%)	213 (88.0%)	128 (52.9%)
Somewhat Likely	9 (3.7%)	12 (5.0%)	72 (29.8%)
Not at all Likely	14 (5.8%)	16 (6.6%)	42 (17.4%)

Table 4.3. Fourth-year dental students' knowledge, skills, self-efficacy and behavioral intention to use fluoride varnish, dental sealants and silver diamine fluoride with patients

Characteristics	Self-Efficacy to Use 3 Caries Preventive Regimens		Behavioral Intention to Use 3 Caries Preventive Regimens	
	Mean Score	P-value	Mean Score	P-value
Type of school				
Public	2.54		2.60	
Private	2.72	<.01	2.74	.03
Country of birth				
US	2.63		2.69	
Not US	2.58	.55	2.57	.11
Gender				
Female	2.59		2.65	
Male	2.66	.26	2.67	.76
Ethnicity Hispanic or Latino[†]				
Yes	2.58		2.62	
No	2.62	.69	2.67	.70
Race				
White	2.61		2.66	
Non-white	2.63	.77	2.66	.90
Education/training in CPR[†]				
Yes	2.63		2.69	
No	1.92	<.01	1.67	<.01

Table 4.4. Analysis of variance of socio-demographic variables and self-efficacy and behavioral intention to use three caries preventive regimens (n=242).

	Predictor Variable	Dependent Variable	Odds Ratio	95% CI	P-value
Model 1					
Does higher behavioral capability predict higher self-efficacy to use 3 caries preventive regimens?	Behavioral Capability	Self-Efficacy	18.713	(8.425, 41.565)	<.01
Model 2					
Does higher self-efficacy predict higher behavioral intention to use 3 caries preventive regimens?	Self-Efficacy	Behavioral Intention	21.344	(10.615, 42.916)	<.01
Model 3					
Does higher behavioral capability predict higher behavioral intention to use 3 caries preventive regimens?	Behavioral Capability	Behavioral Intention	5.410	(3.058, 9.569)	<.01
Model 4					
Does higher self-efficacy continue to predict higher behavioral intention to use 3 caries preventive regimens once behavioral capability is included in the model?	Behavioral Capability	Behavioral Intention	1.495	(0.724, 3.085)	.28
	Self-Efficacy		17.458	(8.032, 37.946)	<.01

Number of participants in low/medium (L/M) and High groups for each variable: Behavioral Capability: L/M (n=88), High (n=154); Self-Efficacy: L/M (n=158), High (n=84); Behavioral Intention L/M (n=160), High (n=82)

Table 4.5. Logistic regression models predicting self-efficacy (Model 1) and behavioral intention (Models 2-4) to use three caries preventive regimens (n=242).

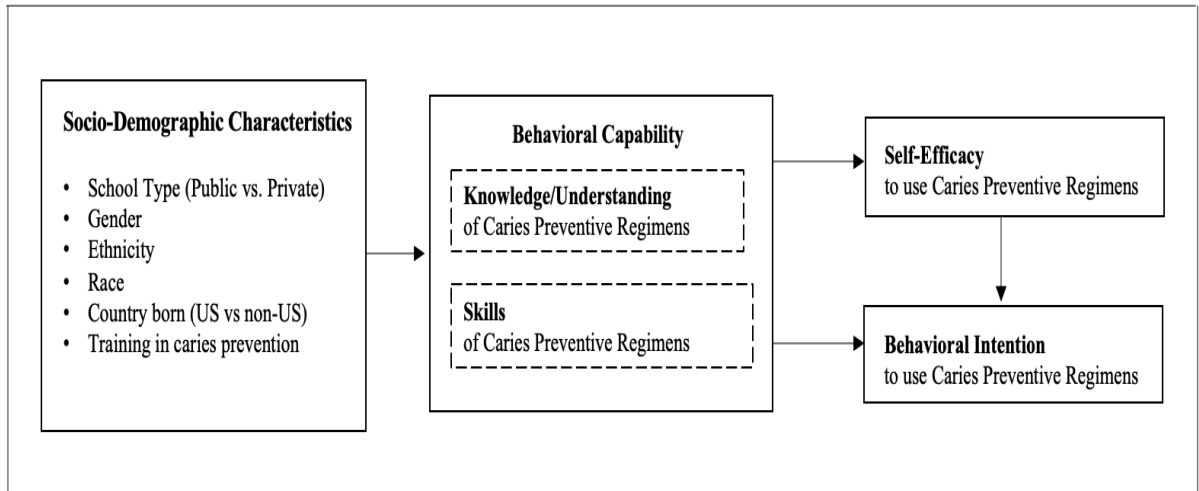


Figure 4.1. Conceptual model of dental students' behavioral capability, self-efficacy and behavioral intention to use selected caries preventive regimens.

Chapter 5: Discussion

Section 5.1: Communication Techniques

Dental schools are responsible for providing foundational education for their students. Previous research suggests two topics not emphasized in most dental school curricula: education and training related to communication skills and caries prevention.^{19,46,47,51–56,145,148–151} Our findings suggest some schools have implemented courses to support the CODA communication/interpersonal skills competencies. Specifically, 86.0 percent of students reported they had received education and training on the seventeen communication techniques in their dental program. However, other responses suggest some dental schools should place greater emphasis on these competencies so all students graduate with these essential skills. For example, only 59.0 percent of students indicated they had ever taken a communications course and less than a quarter reported taking a standalone communications course versus lectures on communication integrated within other courses. Further, less than 70 percent of students reported their school used methods that help standardize training, including the use of standardized patients or actors for training, written scripts to educate patients and patient education materials assessed for readability and suitability. These methods can help reduce variation in clinical treatment, reduce the potential for errors, improve the quality of care and lead to better patient outcomes. In addition, less than 75 percent of students reported that key interpersonal skills are taught at their dental school. Interpersonal skills, such as asking patients to explain their understanding of their dental problem, offering to help

patients complete forms and enlisting help from a patient's family members or friends to promote understanding, are key to providing patient-centered care. These skills are necessary for effective provider-patient communication and one approach to ensure all students receive this training is to teach these skills in a standalone course.

Responses for the communication techniques measures of knowledge/understanding and skills were higher than those for self-efficacy and behavioral intention. The highest percentages for the knowledge/understanding and skills were 98 percent compared with 80 percent for the self-efficacy and behavioral intention measures. This gap between the measures could be due to a lack of emphasis on communication techniques in the clinic and/or a lack of emphasis on evaluations. If communication techniques are taught in class with limited or no practice with patients, one would not expect high self-efficacy to use the techniques. It follows that a student would not intend to use a technique they did not have confidence in using. The gap between behavioral capability and self-efficacy may be greater than our findings indicate. Our sample may have been more motivated to respond to the survey because of their interest in the topic, and thus our results may underestimate gaps in learning.

It is not surprising students do not intend to use most of the communication techniques with patients after graduation because a majority reported they did not have a standalone course on communication skills. To address this deficiency in the curricula, dental schools should provide a standalone communications course that covers the depth and breadth of this important skill and evaluates students on these competencies. Another suggestion is to incorporate behavioral theory constructs into

communication skills courses to better understand and predict clinical practice behavior.^{213,214,222,225} Courses should emphasize self-efficacy because it plays an important role in individuals adopting a new skill.²²⁵ For dental schools that currently have a standalone communication skills course, courses should be examined and revised to include behavioral theory constructs.

Our study results are similar to those from the national and Maryland surveys of general dentists conducted over a decade ago. The previous studies found dentists routinely used a low percentage of communication techniques and our study found a low percentage of students who had high levels of behavioral intention to use the techniques.^{61,62} The outcome measures differed between our study and the previous studies. We measured behavioral intention and the previous studies measured reported behavior. We think our findings provide insight into students' behavioral intention, which is a strong predictor of future behavior.^{60,207}

Section 5.2: Caries Preventive Regimens

For graduating dentists to have the knowledge, understanding and skills to follow the ADA's current guidance for dental caries prevention and management, their undergraduate dental education must emphasize risk assessment, preventive regimens and a conservative approach to treating caries that minimizes surgical intervention. Our findings suggest some dental schools need to place greater emphasis on teaching and evaluating caries prevention. For example, of thirteen factors used to assess caries risk in children 0-6 years of age only three were selected by over 90 percent of respondents. It is important for students to be educated about these

additional risk factors so they can form a more comprehensive risk profile to identify patients at high risk for dental caries and create individualized care plans.^{148,227}

In addition, only 65.0 percent of students reported they had the skills to apply silver diamine fluoride and less than half (43.0%) reported a high level of self-efficacy to apply silver diamine fluoride. All students should receive education and training in current caries preventive regimens so they can use evidence-based approaches when caring for patients. Further, only 70 percent of students reported being evaluated on the three caries preventive regimens in both the classroom and clinic. Students should be evaluated in both locations to ensure they meet the caries prevention competencies. Finally, just as we recommended for communication skills courses, caries prevention courses should be based on behavioral theory and emphasize self-efficacy and hands on practice.^{213,214,222,225}

Section 5.3: Measurement

To our knowledge, this study is the first to use behavioral theory constructs in a national survey of dental students. Thus, our measures, while based on behavioral theory were exploratory in nature. For the variables, knowledge/understanding and skills, we used a 2-point scale ('yes'/'no' response options) and a 3-point scale for the self-efficacy and behavioral intention measures. Our data was highly skewed to the high-end of our scales and there was little differentiation. Future studies could explore using a 5- or 7-point scale to assess the effect on responses such as greater differentiation in responses and less skewed data. Also, we would use the same point scale for all measures.

Another aspect of the independent and dependent variables in our study is our approach to categorizing the variables for the logistic regression analysis. Our approach is based on that used in the national of dental providers and state surveys of dental and medical providers related to routine use of the communication techniques.^{61–65} For each index, we summed the items and then used SPSS to divide the responses into three approximately equal groups – low, medium and high scores. We combined the low and medium groups into one group (called low/medium group) and examined the relationships between the groups. We chose to compare the low/medium group to the high group because it is our expectation that dental students and future dental students have the skills to communicate effectively with all patients at all encounters, i.e. they would be in the high scoring group. Future studies could examine differences between two and three categories.

Section 5.4: Conclusions

Also, there are several steps dental schools can take to place greater emphasis on communication skills and caries prevention competencies in their undergraduate programs. Study findings can be used as a basis for examining individual dental school programs and can help inform curricula development, implementation and board examinations. As part of this process, dental schools could conduct a health literacy environmental scan of their facility and take steps to become a health literate health care organization.^{228,229} A scan could help schools assess faculty and staff education and training related to these competences, and the amount of time allocated to teaching these two competencies and the context in which they are taught. Future research should examine dental school curricula and conduct in-depth interviews with

individuals responsible for teaching these competencies to gain a more complete view of how communication skills and caries prevention are taught and evaluated in the schools.

To reduce the prevalence of dental caries and associated oral health disparities in the United States, students must leave dental school with current, evidence-based knowledge and skills, as well as the self-efficacy to assess caries risk and use a conservative approach to manage and treat dental caries. Also, dental students must be able to communicate effectively with all patients because they will play an important role in educating their patients about best practices to obtain and maintain good oral health, which can potentially increase patient oral health literacy and oral health status. Changes in the dental education curricula and greater oversight by CODA could help bring about these changes.

Section 5.5: Study Limitations

Our survey response rate was low and not all dental schools were represented in the study. In addition, respondents may have attended a dental school that placed greater emphasis on communication skills or caries prevention in their curriculum making students more likely to respond to the survey. Thus, it is possible respondents were not representative of their cohort. Further, our study used self-report data, and social desirability may have affected responses.

The study was adequately powered but the sample was small, and respondents differed demographically from their cohort. A larger sample might have reduced response bias and provided a more representative insight into the D4 student population's education related to caries preventive regimens. Future studies should

review dental school curricula and conduct in-depth interviews with individuals who provide caries prevention education for a more comprehensive understanding of the teaching and evaluation related to this competency.

The survey design appeared to affect completeness of the data. First, the survey was not optimally designed for smartphone users. The layout required users to scroll up and down and left to right. Respondents did scroll up and down to select responses, but many respondents did not scroll to the right and missed entering all data for the Skills and behavioral intention measures. In addition, the survey had too many communication techniques items, which placed a burden on respondents. We noticed a falloff in responses as respondents progressed through the survey. If this instrument is used in the future, the number of communication items should be reduced. Finally, the Cronbach's alpha values for the three caries preventive regimens measures (behavioral capability, self-efficacy and behavioral intention) was adequate.²³⁰ Future studies could explore adding additional items to the scales to increase reliability.

Appendices

Appendix A: Methods

Section A.1: Theoretical Model

The conceptual framework for this study is based on Social Cognitive Theory (SCT) and the Theory of Planned Behavior (TPB) constructs.^{58,207,208} We measured two SCT constructs and one TPB construct. The two SCT constructs are Behavioral Capability and Self-Efficacy^{58,225} and the TPB construct is Behavioral Intention.^{207,208} Behavioral Capability is an individual's ability to use knowledge and skills to perform a behavior.²²³ In our study behavioral capability is dental students' knowledge and skills to use seventeen communication techniques and three caries preventive regimens. Self-Efficacy is students' confidence to use the communication techniques and caries preventive regimens. Our primary outcome is students' behavioral intention to use the communication techniques and caries preventive regimens with patients after graduation. Our research examined the relationships between these constructs. We predicted that students with higher behavioral capability had higher self-efficacy and behavioral intention; and students with higher self-efficacy had higher behavioral intention. The conceptual framework is depicted in two graphics. Figure A.1 shows the predicted relationships between the constructs used to assess communication skills and Figure A.2 presents the predicted relationships between the constructs used to assess the caries preventive regimens. See Figures A.1 and A.2.

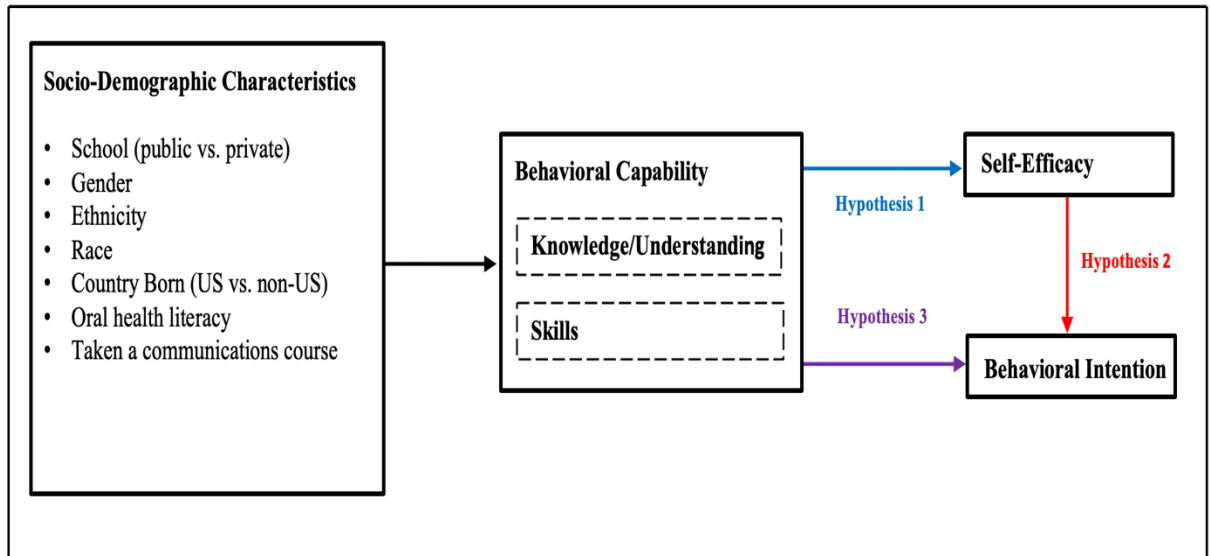


Figure A.1. Conceptual model of dental students' behavioral capability, self-efficacy and behavioral intention to use selected communication techniques.

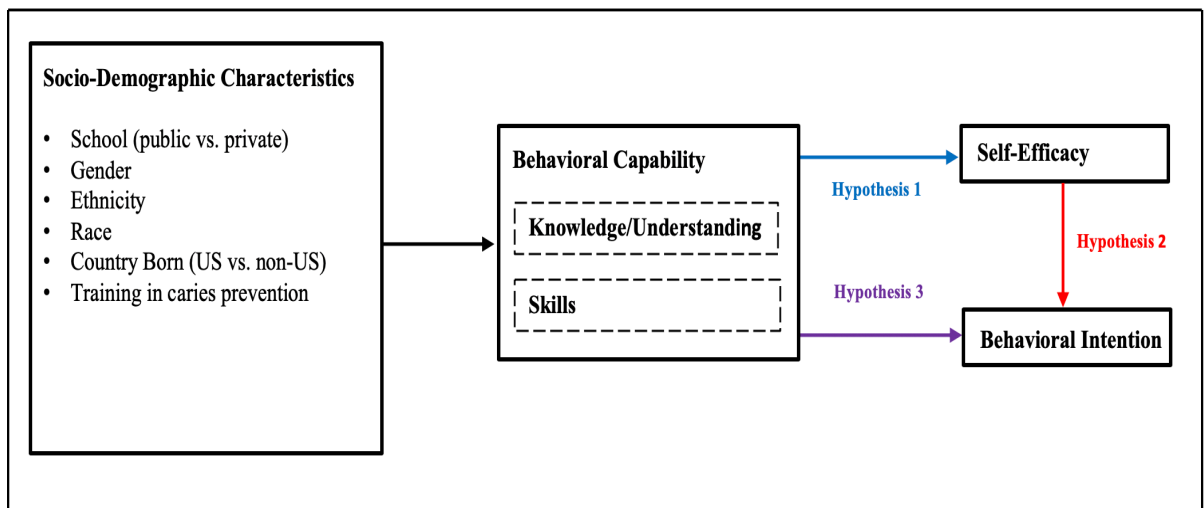


Figure A.2. Conceptual model of dental students' behavioral capability, self-efficacy and behavioral intention to use selected caries preventive regimens.

Section A.2: Procedures

Section A.2.1: Description of the Study Population

There are sixty-six accredited dental schools in the United States. Forty-four schools are public and twenty-two are private.⁶⁶ The study population was fourth-year dental (D4) students attending these 66 schools. We estimated our sample population to be approximately 6,000 students based on data collected about the 2015-2016 enrolled class from the American Dental Association's (ADA's) Annual survey of Dental Education.

According to the ADA, 50.9 percent of students were male, and 48.8 percent were female. Fifty-five percent were white; 23.3% were Asian; less than ten percent were Latino (8.9%); and only five percent (5.3%) were Black/African American. See Table A.1.

Characteristic	n (%)
Gender	
Female	2,929 (48.8%)
Male	3,053 (50.9%)
Race and Ethnicity	
White	3,261 (54.4%)
Asian	1,397 (23.3%)
Latino	532 (8.9%)
African American	320 (5.3%)
Two or more races	169 (2.8%)
American Indian/Alaska Native	17 (0.3%)
Native Hawaiian/Pacific Islander	7 (0.1%)
Non/Resident Alien	193 (3.2%)
Unknown	104 (1.7%)

Table A.1. United States dental school enrollment by gender and race and ethnicity for academic year 2015-2016 (n=6,000). Source: American Dental Association Annual Survey of Dental Education: Academic Programs, Enrollment and Graduates, 2017⁶⁶

When we conceived the study, we planned to survey both third- and fourth-year students, which would have increased our sample population to approximately 12, 000 students. However, the ADA/CODA/ADEA Joint Advisory Committee on Dental Education Information (ACDEI) only gave approval to survey D4 students, and not third year dental (D3) students.

Section A.2.2: Description of the Sampling Procedure

Section A.2.2.1: Sampling Procedure

The ADA Health Policy Institute (HPI) received D4 student email addresses from the American Student Dental Association (ASDA). The ASDA reported that 95 percent of students who attend U.S. dental schools are members of their organization (ASDA membership coordinator, personal communication, November 27, 2017).

Section A.2.2.2: Power Analysis

We conducted a power analysis using G*Power Version 3.1.9 to determine the minimum sample size needed to adequately power our study. There was no guidance on effect size in the literature for oral health studies similar to the proposed research. Thus, we ran the sample calculation multiple times using small and medium effects based on Cohen's definition of effect sizes.²³¹ After consultation with a member of the dissertation committee, we decided to use a small effect size value of 0.2. According to G*Power, our study will be adequately with a response rate of $n=117$. The following parameters were used in the power calculation:

- Test Family: F test
- P-value: 0.05
- Power: 0.95
- Effect size: 0.2 (small)
- Number of predictors: 7

Section A.2.2.3: Response Rate

Of the 6,123 email addresses, sixty-one were invalid and one was a duplicate resulting in a sampling frame of 6,061 students. Of these, 344 respondents started the survey and 242 submitted the survey for a response rate of 4.0 percent.

We did not find published response rates for national surveys of dental students for either paper or online surveys. The ASDA does not have statistics on response rates for a national survey of dental students (ASDA membership coordinator, personal communication, November 27, 2017). Thus, we looked at response rates for online surveys of dental and medical providers. In recent national surveys of dentists, the response rate for a survey of pediatric dentists about office-based sedation was 26 percent²³² and a survey of general practice dentists and dental specialists about sedation in the outpatient setting yielded a response rate of 9.8percent.²³³ In a state study, only 21 percent of dentists responded to a Florida Tobacco Control Survey.²³⁴ We researched surveys of medical providers and found that response rates were typically in the range of 20-40 percent.^{235,236} According to Cunningham and colleagues (2015), possible reasons for the low response rates to web-based surveys are survey recruitment methods, mode, design, length, topic, sensitivity of the survey topic, and medical specialty.²³⁵

Section A.2.3: Description of the Survey Instrument

Our survey instrument, *Survey of Dental Students: Communication Techniques and Caries Prevention*, collected data about two important aspects of dental education – communication skills and caries preventive regimens. The survey had 34 questions. One quarter were related to communication techniques and another quarter were related to caries preventive regimens. The remaining questions asked about students' demographic characteristics, patient characteristics, opinions about teaching communication skills courses in dental school, teaching methods and preferred provider practices used in their dental school.

Fourteen questions asked about communication techniques. These questions asked whether students had received training in the communication techniques; whether students had the knowledge, skills self-efficacy and behavioral intention related to the techniques; if they were evaluated on their use of the techniques; and their opinions about teaching communication skills courses in dental school. Nine questions inquired about the three caries preventive regimens. These questions asked about the risk factors students used to assess caries risk in children; whether students received training in the three caries preventive regimens; whether students had the knowledge, skills, self-efficacy and behavioral intention related to the caries preventive regimens; and if they were evaluated on their use of the regimens. Three questions assessed the types of preferred provider practices taught in dental school. Eight questions inquired about demographic characteristics including: gender; ethnicity; race; type of dental school the student attended; plans for the first year after

graduation; the country where they were born; and if they had heard of oral health literacy. See Appendix D: Survey Instrument.

Section A.2.4: Survey Development

Our survey was adapted from a national survey of general dentists regarding their routine use of 18 communication techniques by Rozier, Horowitz and Podshun (2011).⁶¹ It also was based on studies by Horowitz and colleagues (2013; 2013; 2015; 2016) that examined Maryland health care providers' use of these communication techniques and caries preventive regimens.^{62–65} The health care providers in these studies included general dentists, pediatric dentists, dental hygienists, family physicians, pediatricians and nurse practitioners.

We adapted our survey in several ways. First, our primary outcome measure was different from those used in the national and Maryland surveys. The previous surveys measured health care practitioners' 'routine use' of the communication techniques. 'Routine use' was defined as how often the health care practitioner used each technique during a typical week and it was measured using a 5-point Likert scale with response items ranging from 'always' to 'never'.^{61–65} Our primary outcome measure was D4 students' behavioral intention to use the communication techniques with patients after they graduate. We measured intention to perform a behavior rather than behavior because dental students were not yet practicing on their own. We also measured self-efficacy because it is often a predictor of behavioral intention.^{58,59,214}

Second, the survey contained a new area of investigation – the use of selected caries preventive regimens. We added questions about three caries preventive

regimens to the survey because it is an area of interest to the ADA. These evidence-based regimens are the best way to prevent dental caries, so we wanted to understand D4 students' exposure to the regimens as well as their confidence in and intention to use these regimens with patients after they graduate. Similar to the assessment of communication techniques, the primary outcome measure was D4 students' behavioral intention to use the regimens with their patients after graduation. The questions about caries preventive regimens were formatted similarly to the questions about communication techniques.

Third, to ground the research in behavioral theory, we added questions to assess SCT and the TPB constructs. The constructs were behavioral capability (knowledge and skills), self-efficacy and behavioral intention.^{58–60,208} The survey assessed students' knowledge, skills, self-efficacy and behavioral intention to use the communication techniques and caries preventive regimens with their patients after graduation.

We drafted the survey in May and June of 2017. We pilot tested a MS Word version of the survey with a dental student who graduated in May 2017 to get feedback on question clarity, survey flow, formatting and the time required to complete the survey. We revised the survey based on this feedback and sent it to 10 additional students. Six of the 10 students provided feedback. We made minor revisions to question wording and formatting based on their feedback.

In July 2017, we sent the survey to the National Advisory Committee on Health Literacy in Dentistry, ADA Council: Council on Advocacy for Access and

Prevention (CAAP). In September, we received feedback from three members of the Council and from a member of the dissertation committee. We revised the survey based on these comments and to better reflect our measures. The survey was submitted to the CAAP on November 1, 2017 and they approved the study. Staff from the CAAP created the online version of the survey using Qualtrics XM and ADA's HPI staff tested the survey.²³⁷ The CAAP and the ADA/CODA/ADEA Joint Advisory Committee on Dental Education Information (ACDEI) reviewed the survey and provided comments that were incorporated. The ADA HPI administered the survey in July 2018 and provided us with a de-identified data file. We analyzed the data. The study was exempt from review by the University of Maryland Institutional Review Board.

Section A.2.5: Survey Implementation

The HPI obtained D4 student email addresses (n=6,123) from ASDA. In July 2018, the CAAP staff sent students an email that explained the study purpose, invited students to participate and included a link to the confidential online survey. The survey was open for eight weeks. Three follow-up reminders were sent: one week after the survey opened; three weeks later; and one week later.

To increase participation, the CAAP sent an email to all dental school deans to make them aware of the survey and to ask them to encourage their students to complete the survey. They sent a letter to senior management at the American Dental Education Association (ADEA) requesting they encourage faculty to support the survey. Also, the CAAP offered a raffle of five \$100 Amazon gift cards to students who completed the survey and elected to be in a drawing. Five students were selected

in October 2018. The HPI staff provided us a de-identified data file for analysis in October 2018.

Section A.2.6: Human Subjects Concerns

The ADA disseminated the survey to D4 students via email. The email provided the name of the organization conducting the survey; described the purpose of the survey; stated the survey is voluntary and confidential; and provided the contact information for the person at the ADA if respondents had questions about the survey. The email also provided the option to opt out of the survey. When respondents clicked on the survey link, it took them to the survey home page which again described the purpose of the survey; stated the survey is voluntary, confidential and they could skip any question they did not want to answer; and mentioned the opportunity to enter a raffle to win one of five \$100 Amazon gift cards after completing the survey. The ADA used implied consent meaning the respondent gives consent if they click on the survey link and respond to survey questions.

The ADA provided us with a file with containing de-identified data – there was no identifiable private information such as email address. We were not be able to identify respondents directly or through identifiers linked to them. This research was a secondary data analysis, so it was exempt from review by the University of Maryland Institutional Review Board. The data was stored on a personal laptop that was kept in the researcher's home. The laptop is password protected and runs Microsoft Security Essentials virus protection security software built into the

Windows 10 operating system. The laptop is not typically connected to the network, but the network is secured using secure, encrypted WiFi.

Section A.3: Analysis

Section A.3.1: Measures

Section A.3.1.1 defines the communication techniques measures. Section A.3.1.2 defines the caries preventive regimens measures. Section A.3.1.3 defines measures that describe dental student demographic characteristics and preferred provider practices taught in their school. See Table A.2.

<i>Independent Variables</i>		
Communication Techniques (CT)		Caries Preventive Regimens (CPRS)
Knowledge-CT-17	Knowledge-CT-7	Knowledge-CPR
Skills-CT-17	Skills-CT-17	Skills-CPR
BC-CT-17	BC-CT-17	BC-CPR
SE-CT-17	SE-CT-17	SE-CT
<i>Dependent Variables</i>		
BI-CT-17		BI-CPR
BI-CT-7		
<i>Demographic Variables</i>		
Ever Taken a Communications Course		
Country where born (U.S. vs. non-U.S.)		
Gender		
Ethnicity		
Heard of Health Literacy/Oral Health Literacy		
Race		
School (Public vs. Private Dental School)		
<i>Descriptive Variables</i>		
Preferred Provider Practices		
Teaching Methods		
Caries Risk Assessment		
BC = Behavioral Capability; SE = Self-Efficacy; BI = Behavioral Intention		

Table A.2. Independent, dependent, demographic and descriptive Measures.

Section A.3.1.1: Measures - Communication Techniques

The survey assessed 17 communication techniques that are grouped into five domains. The five domains are: Inter-personal communications, Teach-back method, Patient-friendly materials and aids, Assistance, and Patient-friendly practice. We analyzed the 17 techniques and a subset of these techniques, called the seven basic techniques, similar to the analysis in the previous national and state surveys of dentists. We examined these seven techniques separately because they are skills every health care provider should use routinely with all patients.¹²¹ The seven techniques are from the Interpersonal Communication and Teach-back Method domains. See Table A.2.

Interpersonal Communication **

- Limit the number of concepts presented at a time to two to three
- Ask patients whether they would like a family member or friend to accompany them in the discussion
- Draw pictures or use printed illustrations
- Speak slowly
- Use simple language

Teach-back Method **

- Ask patients to repeat back information or instructions
- Ask patients to tell you what they will do at home to follow instructions

Patient-friendly materials and aids

- Use video or DVDs
- Hand out printed materials
- Use models or x-rays to explain

Assistance

- Underline key points on print materials
- Follow-up with patients by telephone to check understanding and adherence
- Read instructions out loud
- Write or print out instructions

Patient-friendly practices

- Ask patients how they learn best
- Refer Patients to the internet or other sources of information
- Use a translator or interpreter when needed

** The communication techniques in the Interpersonal Communication and Teach-back Method domains comprise the seven basic communication techniques.

Table A.3. Communication techniques by domain.

Independent Variables

There were eight independent variables. Four variables were used to analyze the 17 techniques (Knowledge-CT-17, Skills-CT-17, Behavioral Capability-CT-17 and Self-Efficacy-17) and four variables were used to analyze the seven basic techniques (Knowledge-CT-7, Skills-CT-7, Behavioral Capability-CT- 7, and Self-Efficacy-7) .

Knowledge-Communication Techniques (Knowledge-CT-17). Knowledge-CT-17 is an index that ranged in value from 0 to 17. The survey asked students if they had knowledge/ understanding of each of the 17 communication techniques. Response options were ‘yes’ or ‘no’. Each ‘yes’ answer was scored as ‘1’ point and each ‘no’ answer as ‘0’ points. The 17 items were averaged to create the index.

Knowledge-Communication Techniques-7 (Knowledge-CT-7). Knowledge-CT-7 is an index that ranged in value from 0 to 7. The survey asked students if they had knowledge/understanding of each of the 7 communication techniques. Response options were ‘yes’ or ‘no’. Each ‘yes’ answer was scored as ‘1’ point and each ‘no’ answer as ‘0’ points. The 7 items were averaged to create the index.

Skills-Communication Techniques (Skills-CT-17). Skills-CT-17 is an index that ranged in value from 0 to 17. The survey asked students if they had skills to use each of the 17 communication techniques. Response options were ‘yes’ or ‘no’. Each ‘yes’ answer was scored as ‘1’ point and each ‘no’ answer as ‘0’ points. The 17 items were averaged to create the index.

Skills-Communication Techniques-7 (Skills-CT-7). Skills-CT-7 is an index that ranged in value from 0 to 7. The survey asked students if they had skills to use each of the seven communication techniques. Response options were ‘yes’ or ‘no’. Each ‘yes’ answer was scored as ‘1’ point and each ‘no’ as ‘0’ points. The 7 items were averaged to create the index.

Behavioral Capability-Communication Techniques-17 (Behavioral-Capability-CT-17). Behavioral Capability-CT-17 is an index created by summing the scores of the Knowledge-CT-17 and Skills-CT-17 variables and averaging the items. The index ranged in value from 0-34.

Behavioral Capability-Communication Techniques-7 (Behavioral-Capability-CT-7). Behavioral Capability-CT-7 is an index created by adding scores of the Knowledge-CT-7 and Skills-CT-7 variables and averaging the items. The index ranged in value from 0-14.

Self-Efficacy-Communication Techniques (SE-CT-17). SE-CT-17 is an index that ranged in value from 17-51. The survey asked students to rate their confidence to use each of the 17 communication techniques with their patients. Students indicated their confidence using a Likert-type scale with three response options that were scored as

follows: ‘Not at all confident’ = ‘1’ point; ‘Somewhat confident’ = ‘2’ points; and ‘Extremely confident’ = ‘3’ points. The 17 items were averaged to create the index.

Self-Efficacy-Communication Techniques-7 (SE-CT-7). SE-CT-7 is an index that ranged in value from 7 to 21. The survey asked students to rate their confidence to use each of the seven basic communication techniques with their patients. Students indicated their confidence using a Likert-type scale with three response options that were scored as follows: ‘Not at all confident’ = ‘1’ point; ‘Somewhat confident’ = ‘2’ points; and ‘Extremely confident’ = ‘3’ points. The 7 items are averaged to create the index.

Dependent Variables

Behavioral Intention-Communication Techniques (BI-CT-17). BI-CT-17 is an index that ranged in value from 17-51. The survey asked students to rate their intention to use each of the 17 communication techniques with patients after graduation. Students indicated their intention using a Likert-type scale with three response options that were scored as follows: ‘Not at all likely’ = ‘1’ point; ‘Somewhat likely’ = ‘2’ points; and ‘Extremely likely’ = ‘3’ points. The 17 items were averaged to create the index.

Behavioral Intention-Communication Techniques-7 (BI-CT-7). BI-CT-7 is an index that ranged in value from 7 to 21. The survey asked students to rate their intention to use each of the seven basic communication techniques with patients after graduation. Students indicated their confidence using a Likert-type scale with three response options that were scored as follows: ‘Not at all likely’ = ‘1’ point;

‘Somewhat likely’ = ‘2’ points; and ‘Extremely likely’ = ‘3’ points. The 7 items were averaged to create the index.

Section A.3.1.2: Measures - Caries Preventive Regimens

Independent Variables

Knowledge-Caries Preventive Regimens (Knowledge-CPR) is an index that ranged in value from 0 to 3. The survey asked students if they had knowledge/understanding of each of the three caries preventive regimens. Response options were ‘yes’ or ‘no’. Each ‘yes’ answer was scored as ‘1’ point and each ‘no’ answer as ‘0’ points. The 3 items were averaged to create the index.

Skills-Caries Preventive Regimens (Skills-CPR) is an index that ranged in value from 0 to 3. The survey asked students if they had skills to use each of the three caries preventive regimens. Response options were ‘yes’ or ‘no’. Each ‘yes’ answer was scored as ‘1’ point and each ‘no’ answer as ‘0’ points. The 3 items were averaged to create the index.

Behavioral Capability-Caries Preventive Regimens (BC-CPR). BC-CPR is an index created by adding scores of the Knowledge-CPR and Skills-CPR variables and averaging the items. The index ranged in value from 0-6. The index scores were categorized into three approximately equal groups to represent low, medium and high scores using SPSS. The low and medium groups were combined and used as the reference group in the logistic regression analysis to compare scores of the low/medium group to the group with the highest scores.

Self-efficacy-Caries Preventive Regimens (SE-CPR) is an index that ranged in value from 3-9. The survey asked students to rate their confidence to use each of the

three caries preventive regimens with their patients. Students indicated their confidence using a Likert-type scale with three response options that were scored as follows: 'Not at all confident' = '1' point; 'Somewhat confident' = '2' points; and 'Extremely confident' = '3' points. The three items were averaged to create the index. The index scores were categorized into three approximately equal groups to represent low, medium and high scores using SPSS. The low and medium groups were combined and used as the reference group in the logistic regression analysis to compare scores of the low/medium group to the group with the highest scores.

Dependent Variables

Behavioral Intention-Caries Preventive Regimens (BI-CPR) is an index that ranged in value from 3-9. The survey asked students to rate their intention to use each of the three caries preventive regimens with their patients after graduation. Students indicated their intention using a Likert-type scale with three response options that were scored as follows: 'Not at all likely' = '1' point; 'Somewhat likely' = '2' points; and 'Extremely likely' = '3' points. The three items were averaged to create the index. The index scores were categorized into three approximately equal groups to represent low, medium and high scores using SPSS. The low and medium groups were combined compared to the scores of the group with the highest scores.

Section A.3.1.3: Socio-demographic Variables

There were seven demographic variables: Communications Course, Country, Gender, Ethnicity, Oral Health Literacy, Race, and School.

Communications Course is a categorical variable. The survey asked students if they had ever taken a communications course, module or workshop. Response options were ‘yes’ or ‘no’. Response options were coded as ‘yes’ = ‘1’ and ‘no’ = ‘0’. This variable was only used in the communication technique analysis.

Country is a categorical variable. The survey asked students about the country where they were born. Response options were ‘U.S.’ and ‘Non-U.S.’. Country was coded as ‘U.S.’ = ‘1’ and Non-U.S = ‘0’.

Gender is a categorical variable. The survey asked students their gender. There were four response options: ‘female’, ‘male’, ‘other’, and ‘decline to state’. Gender was coded as: ‘female’ = ‘0’; ‘male’ = ‘1’; ‘other’ = ‘2’; and ‘decline to state’ = ‘3’. We restricted analysis to male and female and treated codes of ‘2’ and ‘3’ as missing data.

Ethnicity is a categorical variable. The survey asked students if they were Hispanic or Latino. Response options were ‘yes’ or ‘no’. Response options were coded as ‘yes’ = ‘1’ and ‘no’ = ‘0’.

Race is a categorical variable. The survey asked students which race they identified as. There were six response options: ‘American Indian/Native Alaskan’, ‘Asian’, ‘Black or African American’, ‘Native Hawaiian/Other Pacific Islander’, ‘White’, and ‘Race/Ethnicity Unknown’. Respondents could select all response items that applied. Response options were coded as follows: ‘White’ = ‘1’, ‘American Indian or Alaska Native’ = ‘2’, ‘Asian’ = ‘3’, ‘Black or African American’ = ‘4’, ‘Native Hawaiian/Other Pacific Islander’ = ‘5’, ‘Race/Ethnicity Unknown’ = ‘6’, and multiple response items selected = ‘7’. In the regression analysis, race was divided

into two groups: White and all other races, with White serving as the reference category.

Oral Health Literacy is a categorical variable. The survey asked students if they had ever heard the term “oral health literacy” or “health literacy”. There were three response options: ‘yes’, ‘no’ and ‘don’t know/not sure’. We combined ‘no’ and ‘don’t know/not sure’ responses. Response options were coded as ‘yes’ = ‘1’ and ‘no/don’t know/not sure’ as ‘0’.

School is a categorical variable. Qualtrics captured the name of the respondents’ dental school. During the data cleansing process we categorized the school as ‘public’ or ‘private’ and coded ‘public’ = ‘1’ and ‘private’ = ‘0’.

Section A.3.1.3: Descriptive Variables.

We used three variables to capture descriptive information about the respondents’ dental educational program. ‘Preferred Provider Practices’ asked about activities students used when interacting with patients and ‘Teaching Methods’ asked about types of methods used in their dental school. ‘Caries Risk Assessment’ captured risk factors respondents used to assess dental caries risk in children 0 to 6 years of age.

Preferred Provider Practices. The survey asked students about nine best practices for engaging with patients. Students selected all practices taught at their dental school. The practices were: ‘Offer to help patients complete forms;’ ‘Encourage patients to ask questions;’ ‘Enlist the help of others (patient’s family or friend) to

promote understanding;’ ‘Sit rather than stand while talking with patients;’ ‘Ask patients to explain their understanding of their dental problems and/or suggested treatments for those problems;’ ‘Provide reading or magnifying glasses;’ ‘Give verbal or written information in multiple languages;’ ‘Greet patients warmly;’ ‘Consistently make eye contact with the patient;’ and ‘Other’. If ‘Other’ was selected, the student was prompted to type in a descriptive response.

Teaching Methods. The survey asked students about five teaching methods and allowed the respondent to select ‘Other’. Students selected all methods used in their dental school. The practices were: ‘Provide lectures on provider-patient communication;’ ‘Patient education materials have been reviewed for readability and suitability;’ ‘Written scripts are used to education patients;’ ‘Standardized patients/actors are used for training;’ ‘Use interpreters or telephone translation;’ ‘Don’t know/Not sure;’ and ‘Other’. If ‘Other’ was selected, the student was prompted to type in a descriptive response.

Caries Risk Assessment. The survey asked students about the caries risk factors they used to assess risk for patients ages 0 to 6 years of age. The risk factors were: ‘Fluoride exposure;’ ‘Sugary food or drinks;’ ‘Eligible for government programs (WIC, Head Start, Medicaid or SCHIP);’ ‘Caries experience of mother, caregiver and/or other siblings;’ ‘Dental home;’ ‘Special health care needs;’ ‘Visual or radiographically evident restorations/cavitated carious lesions;’ ‘Non-cavitated (incipient) carious lesions;’ ‘Teeth missing due to caries;’ ‘Visible plaque;’

‘Dental/orthodontic appliances present;’ ‘Salivary flow;’ and ‘Level of health literacy’.

Section A.3.2: Analysis Plan

We analyzed the data using univariate, bivariate and multivariate statistical methods.

Section A.3.2.1: Univariate Analysis

Analyze the distribution. We examined the frequency distribution of each variable. For categorical variables, we examined the frequency and percentage. For continuous data, we also examined the mean, median, standard deviation, range, skewness, and kurtosis. All independent and dependent variables were negatively skewed and remained so after transforming the data using logarithmic transformation.²³⁸ We used untransformed data for the analysis. See Tables A.4 and A.5.

Response Coding. Variables were coded as described in Section 3.1.

Data Cleansing and Missing data. We evaluated missing data rates, patterns and predictors to determine if data were missing at random or systematically. Using SPSS Missing Value Analysis, we examined missingness for each independent, dependent and demographic variable. We did not find the missingness to be related to observed data. For example, the missing data for the self-efficacy and behavioral intention variables did not appear to be related to any of the demographic variables. Thus, we consider the missing data to be missing at random (MAR).²³⁹

The initial data file from ADA HPI had 352 cases and 242 cases had complete data. The percentage of missing data for the independent and dependent variables ranged from 10.8 percent to 26.4 percent. Of the 110 cases with missing data, 85 cases were missing all dependent variables. These 85 respondents dropped out of the survey after answering knowledge, skills and self-efficacy items for the communication techniques and thus did not answer questions about the caries preventive regimens.

The 25 remaining cases were missing all data for the Skills-CT-17 variable but had data for the Knowledge-CT-17 variable. We think respondents missed the entire Skills-CT-17 question due to questionnaire design - respondents had to scroll to the right to enter answers for the Skills-CT-17 question after answering the Knowledge-CT-17 question. Missing data were greater than ten percent, so for the 25 cases missing Skills-CT-17 data we used multiple imputation (MI) with 40 imputations to reduce possible bias related to item non-response.^{239,240} We ran all analysis twice, first with the complete data set (n=242) and then with the imputed data set (n=267). The overall results for the bivariate and logistic regression analysis were the similar, so we reported data from the data file with complete data.

Statistic	Communication Technique Indices		
	INDEX BC	INDEX SE	INDEX BI
Mean	29.1736	44.8017	43.1983
Std. Error of Mean	.34403	.39489	.54549
Median	31.0000	46.0000	45.0000
Mode	34.00	51.00	51.00
Std. Deviation	5.35182	6.14300	8.48589
Variance	28.642	37.736	72.010
Skewness	-1.300	-.992	-2.663
Std. Error of Skewness	.156	.156	.156
Kurtosis	1.253	.951	10.065
Std. Error of Kurtosis	.312	.312	.312
Minimum	9.00	17.00	2.00
Maximum	34.00	51.00	51.00
N	Valid	242	242
	Missing	0	0

BC = Behavioral Capability; SE = Self-Efficacy; BI= Behavioral Intention

Table A.4. Descriptive statistics for the communication techniques indices.

Statistic	Caries Preventive Regimens Indices		
	INDEX BC	INDEX SE	INDEX BI
Mean	5.3926	7.8471	7.9835
Std. Error of Mean	.05362	.09400	.09816
Median	6.0000	8.0000	9.0000
Mode	6.00	9.00	9.00
Std. Deviation	.83419	1.46231	1.52698
Variance	.696	2.138	2.332
Skewness	-.931	-1.827	-2.038
Std. Error of Skewness	.156	.156	.156
Kurtosis	-.657	3.602	3.912
Std. Error of Kurtosis	.312	.312	.312
Minimum	3.00	2.00	2.00
Maximum	6.00	9.00	9.00
N	Valid	242	242
	Missing	0	0

BC = Behavioral Capability; SE = Self-Efficacy; BI= Behavioral Intention

Table A.5. Descriptive statistics for the caries preventive regimens indices.

Section A.3.2.2: Bivariate Analysis

We conducted bivariate analyses to examine the relationships between each socio-demographic variable and the dependent variable. For the categorical variables, Analysis of Variance (ANOVA) was used to examine group differences in the mean score of the dependent variable.²⁴¹ We reported means (*M*) and standard deviations (*SD*) for each group, F-value, degrees of freedom (numerator, denominator) and the significance level (*p*). Socio-demographic variables that were significantly associated with the dependent variable behavioral intention were included in the multivariate analysis. A $p < .05$ level of significance was used to evaluate all statistical results.

We examined assumptions of the ANOVA test (normality of the distribution; homogeneity of variance; and independence).²⁴¹ The assumption of homogeneity of variance was violated in the test of 'Country of Birth' and the dependent variable behavioral intention, ($p < .01$). The variable was included in the multivariate analysis but was not significant.

We ran separate analyses for the 17 communication techniques and the seven basic techniques. Results of the bivariate analysis for the seven basic techniques are not reported in the first manuscript due to space limitations but are included in Table A.6. Results of the bivariate analysis for the 17 communication techniques are presented in Chapter 3, Table 3.4 and results of the bivariate analysis for the caries preventive regimens are presented in Chapter 4, Table 4.4.

Characteristics	Self-Efficacy to use 7 Basic Communication Techniques		Behavioral Intention to use 7 Basic Communication Techniques	
	Mean Score	P-value	Mean Score	P-value
Type of School				
Public	2.64		2.57	
Private	2.65	.80	2.61	.31
Country of Birth				
US	2.67		2.64	
Not US	2.58	.12	2.45	.02
Gender				
Female	2.63		2.57	
Male	2.67	.34	2.61	.78
Ethnicity Hispanic or Latino[†]				
Yes	2.68		2.68	
No	2.64	.71	2.58	.41
Race				
White	2.66		2.59	
Non-white	2.62	.51	2.58	.85
Ever taken a communications course				
Yes	2.67		2.61	
No	2.61	.19	2.54	.31
Heard of Oral Health Literacy				
Yes	2.65		2.59	
No/Don't know	2.56	.32	2.39	.21

Table A.6. Analysis of variance of socio-demographic variables and self-efficacy and behavioral intention to use seven basic communication techniques (n=242).

Section A.3.2.3: Multivariate Analysis

We used logistic regression to analyze the relationships between the predictor variables behavioral capability and self-efficacy and the outcome behavioral intention.²³⁸ To prepare the data for logistic regression analysis, the values for each independent and dependent variable were divided into three approximately equal groups to represent low, medium and high scores using SPSS. Our approach to categorizing the data into three groups was based on the approach used in the national and Maryland surveys of providers about their use of communication techniques.^{61–65} The low and medium groups were then combined and compared to the group with high scores in logistic regression analysis. The low/medium group was used as the reference group in regression analysis.

We ran four regression models to assess the following: Does higher behavioral capability predict higher self-efficacy; does higher self-efficacy predict higher behavioral intention; does higher behavioral capability predict higher behavioral intention; and when both higher behavioral capability and higher self-efficacy are included in the model, do both continue to independently predict behavioral intention? The regression models included socio-demographic variables that were significant in the bivariate analysis.

Socio-demographic variables that were significant in the bivariate analysis were included in the multivariate analysis. In the bivariate analysis for the communication techniques, ‘county of birth’ was the only significant variable. In the bivariate analysis for the caries preventive regimens, the variables ‘type of school’

and ‘received education and training in the caries preventive regimens’ were significant. These variables were not significant in the multivariate analysis and were removed from the final models. While these variables were statistically significant in the bivariate analysis, the differences were extremely small, and we were not surprised these variables were not significant in the final models.

We ran separate regression models for the 17 communication techniques and the seven basic techniques. Results for the seven basic techniques are not reported in the first manuscript due to space limitations but are included in Table A.7. The results are similar to those of the 17 communication techniques. Results of the regression models for the 17 communication techniques are presented in Chapter 3, Table 3.5 and results of the regression models for the caries preventive regimens are presented in Chapter 4, Table 4.5. We reported odds ratios , significance level (p) and 95% Confidence Interval (CI). A $p < .05$ level of significance was used to evaluate all statistical results.

The six hypotheses we examined were:

Hypothesis 1.1: Dental students who report greater behavioral capability report greater self-efficacy to use the communication techniques with patients compared to dental students who report lower behavioral capability.

Hypothesis 1.2: Dental students who report greater self-efficacy report greater behavioral intention to use the communication techniques with their patients after graduation compared to dental students who report lower self-efficacy.

Hypothesis 1.3: Dental students who report greater behavioral capability report greater behavioral intention to use the communication techniques with patients after graduation compared to dental students who report lower behavioral capability.

Hypothesis 2.1: Dental students who report greater behavioral capability report greater self-efficacy to use the caries preventive regimens with patients compared to dental students who report lower behavioral capability.

Hypothesis 2.2: Dental students who report greater self-efficacy report greater behavioral intention to use the caries preventive regimens with their patients after graduation compared to dental students who report lower self-efficacy.

Hypothesis 2.3: Dental students who report greater behavioral capability report greater behavioral intention to use the caries preventive regimens with patients after graduation compared to dental students who report lower behavioral capability.

	Predictor Variable	Dependent Variable	Odds Ratio	95% CI	P-value
Model 1					
Does higher behavioral capability predict higher self-efficacy to use 7 basic communication techniques?	Behavioral Capability	Self-Efficacy	6.816	(3.711, 12.521)	<.01
Model 2					
Does higher self-efficacy predict higher behavioral intention to use 7 basic communication techniques?	Self-Efficacy	Behavioral Intention	6.790	(3.776, 12.212)	<.01
Model 3					
Does higher behavioral capability predict higher behavioral intention to use 7 basic communication techniques?	Behavioral Capability	Behavioral Intention	3.131	(1.837, 5.335)	<.01
Model 4					
Does higher self-efficacy continue to predict higher behavioral intention to use 7 basic communication techniques once behavioral capability is included in the model?	Behavioral Capability	Behavioral Intention	1.726	(0.942, 3.162)	.08
	Self-Efficacy		5.482	(2.928, 10.263)	<.01
Number of participants in low/medium (L/M) and High groups for each variable: Behavioral Capability: L/M (n=123), High (n=119); Self-Efficacy: L/M (n=157), High (n=85); Behavioral Intention L/M (n=141), High (n=101)					

Table A.7 Logistic regression models predicting self-efficacy (Model 1) and behavioral intention (Models 2-4) to use seven basic communication techniques (n=242).

Section A.3.3: Validity and Reliability

Section A.3.3.1: Validity & Reliability

The National Advisory Committee on Health Literacy in Dentistry (NACHLD) drafted an 86-item questionnaire that included items about the use of communication techniques. Rozier and colleagues (2011) pilot-tested parts of the questionnaire with 188 attendees at the 2007 ADA annual meeting.⁶¹ A NACHLD workgroup discussed the results and revised the questions. The resulting questionnaire included questions about dentists' routine use of 18 communication techniques.⁶¹ These techniques were recommended by the American Medical Association and Schwartzberg and colleagues (2007) had used most of these items in a survey.¹²¹ Rozier and colleagues reported that they did not test the scale for validity or reliability. However, reliability has been established over the years with similar results obtained in numerous surveys with multiple health care provider groups.^{61–65,121} We selected 17 of the 18 items for inclusion in our survey. We dropped one item that asks about current office practices because it is not applicable to students who are not yet practicing. We established content validity for the caries preventive regimens by submitting a draft survey instrument to known experts in the field of dental caries prevention. The instrument was revised based on their feedback.

We used SPSS's Reliability Analysis function to assess reliability of the independent and dependent variables using Cronbach's alpha.^{242,230} Items are considered to have excellent reliability if α is 0.9 or higher; good reliability if α is between 0.8 and 0.9; acceptable reliability if α is between 0.7 and 0.8.; and

questionable reliability if α is between 0.6 and 0.7.²³⁰ The Cronbach's alpha values are presented in Table A.8. For the communication techniques, the Cronbach's alpha values had good to excellent reliability. For the caries preventive regimens, the Cronbach's alpha values were acceptable for two of the indices and questionable for the behavioral capability index.

Indices	Cronbach's Alpha
<i>Communication Techniques</i>	
17 Communication Techniques	
Index-BC-CT-17	.894
Index-SE-CT-17	.911
Index-BI-CT-17	.940
Seven Basic Communication Techniques	
Index-BC-CT-7	.744
Index-SE-CT-7	.826
Index-BI-CT-7	.892
<i>Caries Preventive Regimens</i>	
Index-BC-CPR-17	.664
Index-SE-CPR-17	.738
Index-BI-CPR-17	.775
BC = Behavioral Capability; SE = Self-Efficacy; BI = Behavioral Intention; CPR = Caries Preventive Regimens	

Table A.8. Results of reliability analysis testing for indices.

Appendix B: Survey Instrument

This is the text of the email sent to all fourth-year dental students requesting they participate in the study. The text of the online survey is on the following pages.

ADA American Dental Association*

Survey of Dental Students' Health Literacy Skills

Dear Dental Student:

We need your help!

The American Dental Association Council on Advocacy and Prevention's National Advisory Committee on Health Literacy in Dentistry wants your opinions about what is taught and practiced in U.S. dental schools relating to provider-patient communication techniques and selected caries preventive regimens.

This is a national survey of third- and fourth-year dental students. Your responses will be used to help inform curricula development and board examinations.

Your survey responses are confidential; your name will not be identified with your responses. Your participation is entirely voluntary and much appreciated. The survey will take 15-20 minutes to complete.

Please complete the survey by clicking on the box below.

[Click Here](#)

(If the button has been disabled, please click on URL located near the end of this message to access the survey.)

We hope to receive your response within the next three weeks.

Thank you for taking the time to complete this online survey. If you have any questions, contact Sharee Clough at cloughs@ada.org.

Sharee Clough
Manager, Preventive Health Activities
Council on Advocacy for Access and Prevention

Survey of Dental Students: Communication Techniques and Caries Prevention

Thank you for taking the time to complete this survey. The purpose of the survey is to gain insight into dental students' knowledge, understanding and attitudes regarding patient communication and caries prevention. Your confidential answers will be used to develop interventions to train faculty and students on best practices to improve provider-patient communications and caries prevention. Your participation is voluntary and you can skip any question you do not wish to answer.

Please tell us about the activities you use with the patients you treat.

1. Which of these activities are taught in your dental school?
(Choose ALL that apply.)
 - a. Offer to help patients complete forms
 - b. Encourage patients to ask questions
 - c. Enlist the help of others (patient's family member or friend) to promote understanding
 - d. Sit rather than stand while talking with patients
 - e. Ask patients to explain their understanding of their dental problems and/or suggested treatments for those problems
 - f. Provide reading or magnifying glasses
 - g. Give verbal or written information in multiple languages
 - h. Greet patients warmly
 - i. Consistently make eye contact with the patient
 - j. Other, please specify _____

2. Which of the following are provided in your dental school?
(Choose ALL that apply.)
 - a. Lectures on provider-patient communication
 - b. Patient education materials that have been reviewed for readability and suitability
 - c. Written scripts are used to educate patients
 - d. Standardized patients/actors are used for training
 - e. Interpreters or telephone translation for patients
 - f. Don't know / Not sure
 - g. Other, please specify _____

Please tell us about the patients you treat.

3. What is the greatest challenge you experience with a patient who has difficulty understanding you? **(Choose ONE.)**
- a. There is too little time.
 - b. I need more experience in explaining information in plain language.
 - c. I cannot provide information more simply than I already do.
 - d. I do not speak the patient's language and I do not know what to do.
 - e. The patient does not follow my instructions, regardless of how well I explain them.
 - f. I have not encountered this kind of problem.

Use of communication techniques

4. Have you received education and training in the use of communication skills?
- a. Yes
 - b. No

5. For each of the communication techniques listed below, do you have the knowledge/understanding to use the technique with your patients?

Please answer by selecting 'Yes' or 'No':

		Yes	No
a.	Ask patients to repeat back information or instructions	1	2
b.	Speak slowly	1	2
c.	Present no more than 2 to 3 concepts at a time	1	2
d.	Ask patients to tell you what they will do at home to follow instructions	1	2
e.	Use simple language	1	2
f.	Read instructions out loud	1	2
g.	Hand out printed materials	1	2
h.	Underline key points on print materials	1	2
i.	Write or print out instructions	1	2
j.	Draw pictures or use printed illustrations	1	2
k.	Use a video or DVD	1	2
l.	Use models or x-rays to explain	1	2
m.	Refer patients to the Internet or other sources of information	1	2
n.	Follow-up with patients by telephone to check understanding and adherence	1	2
o.	Ask patients whether they would like a family member or friend in the discussion	1	2
p.	Use a translator or interpreter	1	2
q.	Ask patients how they learn best	1	2

		Do you have the skills to use the technique with your patients?	
		Yes	No
a.	Ask patients to repeat back information or instructions	1	2
b.	Speak slowly	1	2
c.	Present no more than 2 to 3 concepts at a time	1	2
d.	Ask patients to tell you what they will do at home to follow instructions	1	2
e.	Use simple language	1	2
f.	Read instructions out loud	1	2
g.	Hand out printed materials	1	2
h.	Underline key points on print materials	1	2
i.	Write or print out instructions	1	2
j.	Draw pictures or use printed illustrations	1	2
k.	Use a video or DVD	1	2
l.	Use models or x-rays to explain	1	2
m.	Refer patients to the Internet or other sources of information	1	2
n.	Follow-up with patients by telephone to check understanding and adherence	1	2
o.	Ask patients whether they would like a family member or friend in the discussion	1	2
p.	Use a translator or interpreter	1	2
q.	Ask patients how they learn best	1	2

For each of the following communication techniques, please indicate your current level of confidence with, and likelihood to use after graduation

		How confident are you that you can use the technique with your patients?		
		Not at all Confident	Somewhat Confident	Extremely Confident
a.	Ask patients to repeat back information or instructions	1	2	3
b.	Speak slowly	1	2	3
c.	Present no more than 2 to 3 concepts at a time	1	2	3
d.	Ask patients to tell you what they will do at home to follow instructions	1	2	3
e.	Use simple language	1	2	3
f.	Read instructions out loud	1	2	3
g.	Hand out printed materials	1	2	3
h.	Underline key points on print materials	1	2	3
i.	Write or print out instructions	1	2	3
j.	Draw pictures or use printed illustrations	1	2	3
k.	Use a video or DVD	1	2	3
l.	Use models or x-rays to explain	1	2	3
m.	Refer patients to the Internet or other sources of information	1	2	3
n.	Follow-up with patients by telephone to check understanding and adherence	1	2	3
o.	Ask patients whether they would like a family member or friend in the discussion	1	2	3
p.	Use a translator or interpreter	1	2	3
q.	Ask patients how they learn best	1	2	3

		How likely are you to use the technique with your patients after graduation?		
		Not at all Likely	Somewhat Likely	Extremely Likely
a.	Ask patients to repeat back information or instructions	1	2	3
b.	Speak slowly	1	2	3
c.	Present no more than 2 to 3 concepts at a time	1	2	3
d.	Ask patients to tell you what they will do at home to follow instructions	1	2	3
e.	Use simple language	1	2	3
f.	Read instructions out loud	1	2	3
g.	Hand out printed materials	1	2	3
h.	Underline key points on print materials	1	2	3
i.	Write or print out instructions	1	2	3
j.	Draw pictures or use printed illustrations	1	2	3
k.	Use a video or DVD	1	2	3
l.	Use models or x-rays to explain	1	2	3
m.	Refer patients to the Internet or other sources of information	1	2	3
n.	Follow-up with patients by telephone to check understanding and adherence	1	2	3
o.	Ask patients whether they would like a family member or friend in the discussion	1	2	3
p.	Use a translator or interpreter	1	2	3
q.	Ask patients how they learn best	1	2	3

6. Are you currently being, or have you been, evaluated on the use of any of the communication techniques described in the previous question (Q5)?
 - a. Yes
 - b. No (**SKIP to Question 8.**)
7. Where are you or were you evaluated on communication techniques?
 - a. In class only
 - b. In clinic only
 - c. In class and clinic

Use of dental caries preventive regimens

8. Have you received training on how to assess dental caries risk factors for children ages 0-6?
 - a. Yes
 - b. No (**SKIP to Question 10.**)
9. Which of the following dental caries risk factors do you use to assess children, ages 0-6? (**Choose ALL that apply.**)
 - a. Fluoride exposure (through drinking water, supplements, professional applications, toothpaste)
 - b. Sugary food or drinks (including juice, carbonated or non-carbonated soft drinks, energy drinks, medicinal syrups)
 - c. Eligible for government programs (WIC, Head Start, Medicaid or SCHIP)
 - d. Caries experience of mother, caregiver and/or other siblings
 - e. Dental home (established patient of record in a dental office)
 - f. Special health care needs (developmental, physical, medical or mental disabilities that prevent or limit performance of adequate oral health care by themselves or caregivers)
 - g. Visual or radiographically evident restorations/cavitated carious lesions
 - h. Non-cavitated (incipient) carious lesions
 - i. Teeth missing due to caries
 - j. Visible plaque
 - k. Dental/orthodontic appliances present (fixed or removable)
 - l. Salivary flow
 - m. Level of health literacy of caregiver
10. Have you received education and training in the use of caries preventive regimens?
 - a. Yes
 - b. No

11. For each of the caries preventive regimens listed below, please answer by selecting 'Yes' or 'No':

**Do you have the knowledge/
understanding to use the regimen
with your patients?**

	Yes	No
Fluoride varnishes	1	2
Silver Diamine Fluoride	1	2
Pit and fissure sealants for children	1	2

**Do you have the skills to use the
regimen with your patients?**

	Yes	No
Fluoride varnishes	1	2
Silver Diamine Fluoride	1	2
Pit and fissure sealants for children	1	2

For each of the caries preventive regimens listed below, please indicate your current level of confidence with, and likelihood to use after graduation:

**How confident are you that you can use
the regimen with your patients?**

	Not at all Confident	Somewhat Confident	Extremely Confident
Fluoride varnishes	1	2	3
Silver Diamine Fluoride	1	2	3
Pit and fissure sealants for children	1	2	3

**How likely are you to use the regimen with
your patients after graduation?**

	Not at all Likely	Somewhat Likely	Extremely Likely
Fluoride varnishes	1	2	3
Silver Diamine Fluoride	1	2	3
Pit and fissure sealants for children	1	2	3

12. Are you or have you been evaluated on the use of these caries preventive regimens?

Yes

No (**SKIP to Question 14**).

13. Where are or were you evaluated on caries preventive regimens?

In class only

In clinic only

In class and clinic

Tell us something about you.

14. Where were you born?

a. In the United States

b. Outside the United States

15. What is your gender?

a. Female

b. Male

c. Not listed above (Please specify) _____

d. Prefer not to answer

16. Are you Hispanic or Latino?

a. Yes

b. No

17. (continued) What is your race/ethnicity? (**Choose ALL that apply.**)

a. American Indian or Alaska Native

b. Asian

c. Black or African American

d. Native Hawaiian/Other Pacific Islander

e. White

f. Race/ethnicity unknown

18. Do you have family members who are dentists?

a. Yes

b. No (**SKIP to Question 20**)

19. Who in your family is a dentist? (**Choose ALL that apply.**)

a. Grandparent

b. Parent

c. Aunt/Uncle

d. Sibling

20. What is your plan for the first year after graduation from dental school?
(Choose ONE.)
- I plan to practice as an associate and be employed by another dentist.
 - I plan to be an associate in a corporate practice.
 - I plan to be a self-employed dentist.
 - I plan to practice in a community clinic or Federally Qualified Health Center (FQHC).
 - I plan to practice in an Indian Health Service clinic.
 - I plan to enroll in a residency program in a dental specialty.
(identify specialty: _____)
 - I plan to enter a General Practice Residency or Advanced Education in General Dentistry program.
 - I plan to pursue an MPH degree.
 - I plan to pursue an MPH residency.
 - I am unsure about what I will do.

Help us plan educational activities

21. From the following sources of professional knowledge and advice, pick the **two** sources most important to you and **RANK** them, with '1' being the most important and '2' being the second most important.
- Other dentists _____
 - Professional journals, books and newspapers _____
 - Professional meetings and conferences _____
 - CE courses (in the future) _____
 - Internet _____
 - Dental School Faculty _____
22. Have you ever taken a communications course, module or workshop?
- Yes
 - No (**SKIP to Question 27.**)
23. What kinds of communication courses have you taken?
(Choose ALL that apply.)
- Undergraduate communications course
 - Communications course in dental school
 - Lectures on communications integrated within courses in the dental school curricula
 - Other, please specify _____
24. In your opinion, should a communications course be taught in dental school?
- Yes
 - No (**SKIP to Question 27.**)
 - Don't know / Not sure

25. In what year would this course be most beneficial
(Choose ALL that apply.)
- a. 1st year
 - b. 2nd year
 - c. 3rd year
 - d. 4th year
 - e. Don't know / Not sure
26. Where would this course be most beneficial **(Choose ONE.)**
- a. Taught in lecture
 - b. Taught in clinic
 - c. Taught in both lecture and clinic
 - d. Don't know / Not sure
27. Before taking this survey, had you ever heard the term "oral health literacy" or "health literacy?"
- a. Yes
 - b. No **(SKIP to end.)**
28. Where did you hear about it?
(Choose ALL that apply.)
- a. I read about health literacy in a professional journal article.
 - b. A classmate mentioned health literacy in conversation.
 - c. I heard about health literacy in a class.
 - d. I don't recall.
 - e. Other, please specify: _____

Thank you for your assistance with this research project.

A portion of this questionnaire was adapted from the American Medical Association Foundation's "Health Literacy Feedback Survey" and used with permission. Schwartzberg JG, Cowett A, VanGeest J, Wolf MS. Communication techniques for patients with low health literacy: A survey of physicians, nurses and pharmacists. Am J Health Behav. 2007;31(Suppl 1):S96-S104.

Appendix C: IRB Application



1204 Marie Mount Hall
College Park, MD 20742-5125
TEL 301.405.4212
FAX 301.314.1475
irb@umd.edu
www.umresearch.umd.edu/IRB

DATE: April 5, 2018

TO: Catherine Maybury, MPH
FROM: University of Maryland College Park (UMCP) IRB

PROJECT TITLE: [1212433-1] National survey of dental students about their knowledge, skills, self-efficacy and intention to use selected communication techniques and caries preventive regimens

SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF NOT HUMAN SUBJECT RESEARCH
DECISION DATE: April 5, 2018

Thank you for your submission of New Project materials for this project. The University of Maryland College Park (UMCP) IRB has determined this project does not meet the definition of human subject research under the purview of the IRB according to federal regulations.

We will retain a copy of this correspondence within our records.

If you have any questions, please contact the IRB Office at 301-405-4212 or irb@umd.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within University of Maryland College Park (UMCP) IRB's records.

Glossary

American Dental Association (ADA). The ADA is the nation's largest dental association. It is a leading source of oral health information for dentists and their patients and works to advance the dental profession on the national, state and local level. The ADA represents more than 161,000 members from all 50 states, the District of Columbia and Puerto Rico. The ADA is a member-run organization managed by an elected Board of Trustees and a 480-member House of Delegates.²⁴³

American Dental Association Council on Advocacy for Access and Prevention (CAAP). The Council's primary focus is on advocacy for new or improved access programs and the promotion of community prevention strategies.²⁴⁴

American Dental Association Health Policy Institute (HPI). The Health Policy Institute (HPI) is trusted source for critical policy knowledge related to the U.S. dental care system. HPI generates, synthesizes, and disseminates innovative research on topics relevant to policy makers, health care advocates, and providers. HPI examines issues such as health policy reform, access to dental care, the dental workforce, dental care utilization and benefits, dental education, and oral health outcomes.²⁴⁵

American Dental Association National Advisory Committee on Health Literacy in Dentistry (NACHLD). A national advisory committee with experts on health literacy. The committee assists the ADA in developing recommendations about policies, programs, interventions and research related to improving oral health literacy in dentistry; advises about the challenges facing oral health literacy practice and research and making recommendations to minimize these barriers; and reviewing

current ADA policies and making recommendations to for amending and developing oral health literacy related policies; and fostering development of health literacy expertise within the dental profession.¹²⁹

American Dental Education Association (ADEA). ADEA is an organization that works to advance and support dental education, dental research and the dental health and education of the general public. Members include all 76 U.S. and Canadian dental schools, over 800 allied and advanced dental education programs, 66 corporations and more than 20,000 individuals. ADEA's mission is to lead institutions and individuals in the dental education community to address issues that inform education, research and delivery of oral health care.²⁴⁶

American Student Dental Association (ASDA). ASDA is a national student run organization that "protects and advances the rights, interests and welfare of dental students." ASDA has more than 23,000 student members.²⁴⁷

Behavioral Capability. Behavioral Capability is a construct of Social Cognitive Theory. It is an individual's ability to use knowledge and skills to perform a behavior. In this study, it is knowledge/understanding of and the skills to use seventeen communication techniques and three caries preventive regimens.⁵⁸

Behavioral Intention. Behavioral Intention is a construct of the Theory of Planned Behavior. Behavioral Intention is an indication of an individual's likelihood of performing a behavior and it is considered the most proximate predictor of behavior. It is influenced by attitudes towards the behavior, subjective norm and perceived control of the behavior. The stronger the intention to perform the behavior, the more likely the behavior will be performed. In this study, it is intention to use seventeen

communication techniques and three caries preventive regimens with patients after graduation.²⁰⁸

Commission on Dental Accreditation (CODA). CODA was established in 1975 and it is recognized by the United States Department of Education as the sole agency to accredit dental and dental-related education programs conducted at the post-secondary level. CODA develops and administers standards that foster continuous quality improvement of dental and dental related educational programs.²⁴⁸

Cavity. When the hard, outer surface of the tooth (the enamel) is permanently damaged it results in a cavity. If a cavity is not treated, it gets larger and affects the deeper layers of the tooth structure.^{138,249}

Caries preventive regimens. Treatments used to prevent dental caries from developing or progressing. Caries preventive regimens support remineralization, which is a process in which calcium, phosphate and fluoride found in saliva act as a natural buffer to neutralize acid and repair mineral loss in the tooth enamel. These regimens include fluorides and dental sealants.²⁵⁰

Caries risk assessment protocol. A dental caries risk assessment protocol is an evidence-based approach to preventing or treating the cause of dental caries at the earliest stages rather than waiting for irreversible damage to the teeth. When using a risk assessment protocol, each patient is evaluated for his or her unique disease indicators, risk factors and protective factors to determine current and future dental caries disease. Using a risk assessment protocol is more effective at treating/preventing dental caries and more cost effective compared with the approach of applying the same treatments to all patients, independent of their risk. There are a

variety of caries risk assessment forms available from professional associations and industry publications to assist clinicians in determining a patient's risk.^{227,251}

Demineralization. Demineralization and remineralization are naturally occurring processes in the mouth. Demineralization is the loss of minerals from any of the hard tissues (enamel, dentine, cementum) of the tooth. Demineralization is caused by acids produced by bacteria that feed on the carbohydrates in the foods we consume.¹³⁸

Dental caries. Dental caries is a process of demineralization of tooth enamel that leads to destruction of the tooth enamel and dentin and results in tooth decay.¹⁵³

When tooth decay progresses to a hole in the tooth enamel, this is a cavity. Initially the hole may be microscopic, but if left untreated, the decay penetrates the enamel layer. Tooth decay is caused by bacteria that produce acid that destroys the surface of teeth.¹³⁸ The main bacteria involved in the decay process are *Streptococcus mutans*.¹³⁸ These bacteria feed on carbohydrates in the foods we eat, especially sugars, and produce acid. The acid causes calcium and phosphate to leave the enamel in a process called demineralization.¹³⁸

Dental caries risk factors. Factors that can increase the risk of tooth decay. Risk factors include: not getting enough fluoride; not brushing at least twice a day with fluoride toothpaste; consuming food and beverages that contain refined carbohydrates (sugars); frequent snacking and sipping of sugary foods; younger or older age; and dry mouth.²⁵² Dental caries is also associated with low health literacy.^{4,13,14,31–33}

Fluoride varnish. A resin-based fluoride painted directly onto the tooth; it dries quickly. Fluoride varnish provides extra protection against tooth decay when used in addition to brushing teeth regularly with fluoride toothpaste.²⁵

Incipient lesion. An incipient lesion, also called a non-cavitated lesion, is a demineralized lesion without evidence of cavitation (hole in the enamel). Incipient lesions have the capacity for remineralization. This is an early stage of tooth decay and at this stage the demineralization process can be reversed or arrested via biochemical means (e.g., fluoride use), mechanical means (e.g., dental sealant placement), or both.²⁵³ Non-cavitated lesions are characterized by a change in color, glossiness, or surface structure of the tooth as a result of demineralization before there is macroscopic breakdown in the surface tooth structure.²⁵⁴

Oral health literacy. The degree to which individuals have the capacity to obtain, process, and understand basic oral health information and services needed to make appropriate health decisions and act on them.⁶⁸

Pit and fissure dental sealants (dental sealants). A clear or opaque plastic material applied to the pits and fissures of teeth where decay occurs most often. The purpose of dental sealants is to provide a physical barrier to protect the pits and fissures from bacteria and food and prevent cavities.²³

Remineralization. Demineralization and remineralization are naturally occurring processes in the mouth. Remineralization is the natural repair process for non-cavitated lesions in which calcium, phosphate and fluoride are deposited in the demineralized tooth enamel.¹³⁸

Self-Efficacy. Self-Efficacy is a construct of Social Cognitive Theory. It is an individual's confidence in their ability to successfully perform a behavior to attain specific results and overcome barriers to performing the behavior. In this study, it is

confidence to use seventeen communication techniques and three caries preventive regimens with patients.⁵⁹

Silver diamine fluoride. A fluoride that controls active dental caries and prevents further progression of the disease. Silver diamine fluoride acts in two ways. The silver acts as an anti-microbial agent killing bacteria and preventing the formation of new biofilm and the fluoride acts to prevent further demineralization of the tooth.¹⁴²

Social Cognitive Theory. Social Cognitive Theory (SCT) by Albert Bandura posits that behavior is a function of the continuous, dynamic and reciprocal interaction among three factors: personal, behavioral and environmental.⁵⁸ We will measure two SCT constructs, Behavioral Capability and Self-Efficacy.^{58,225}

Theory of Planned Behavior. Ajzen and Fishbein developed the Theory of Reasoned Action (TRA) to predict an individual's intention to engage in a specific behavior.²⁰⁹ Ajzen extended the TRA to include the construct of perceived behavioral control to explain behaviors people have the ability to exert self-control over. The new theory was called the Theory of Planned Behavior (TPB).^{207–209} Behavioral intention is a key construct of this model.

Bibliography

1. Institute of Medicine, Committee on Health Literacy, & Nielsen-Bohlman L. *Health Literacy: A Prescription to End Confusion*. Washington, DC 2001: The National Academies Press; 2004.
2. Berkman ND, Sheridan SL, Donahue KE, et al. Health literacy interventions and outcomes: An updated systematic review. *Ann Intern Med*. 2011;155(2):97-107.
3. Guo Y, Logan HL, Dodd VJ, Muller KE, Marks JG, Riley JL. Health literacy: A pathway to better oral health. *Am J Public Health*. 2014;104(7):85-91.
4. Hom JM, Lee JY, Divaris K, Baker AD, Vann Jr WF. Oral health literacy and knowledge among patients who are pregnant for the first time. *J Am Dent Assoc*. 2012;143(9):972-980.
5. Paasche-Orlow MK, Wolf MS, Professor A. The causal pathways linking health literacy to health outcomes. *Am J Health Behav*. 2007;31(1):19-26.
6. Firmino R, Ferreira F, Palva S, Granville-Garica A, Fraiz F, Martins C. Oral health literacy and associated oral conditions: A systematic review. *J Am Dent Assoc*. 2017;148(8):604-613
7. Divaris K, Lee JY, Baker AD, Vann Jr WF. The relationship of oral health literacy with oral health-related quality of life in a multi-racial sample of low-income female caregivers. *Health Qual Life Outcomes*. 2011;9(1):108.
8. Vann Jr WF, Lee JY, Baker DW, Divaris K. Oral health literacy among female caregivers: Impact on oral health outcomes in early childhood. *J Dent Res*. 2010;89(12):1395-1400.

9. Haridas R, Supreetha S, Ajagannanavar SL, et al. Oral health literacy and oral health status among adults attending dental college hospital in India. *J Int Oral Heal.* 2014;6(6):61-66.
10. Blizniuk A, Ueno M, Zaitso T, Kawaguchi Y. Association of oral health literacy with oral health behaviour and oral health status in Belarus. *Community Dent Health.* 2015;32(3):148-152.
11. Bridges SM, Parthasarathy DS, Wong HM, Yiu CKY, Au TK, McGrath CP. The relationship between caregiver functional oral health literacy and child oral health status. *Patient Educ Couns.* 2014;94(3):411-416.
12. Miller E, Lee JY, DeWalt DA, Vann Jr WF. Impact of caregiver literacy on children's oral health outcomes. *Pediatrics.* 2010;126(1):107-114.
13. Jones M, Lee JY, Rozier RG. Oral health literacy among adult patients seeking dental care. *J Am Dent Assoc.* 2007;138:1199-1208.
14. Lee JY, Divaris K, Baker AD, Rozier RG, Lee SY, Vann Jr WF. Oral health literacy levels among a low-income WIC population. *J Public Health Dent.* 2011;71(2):152-160.
15. Maybury C, Horowitz AM, La Touche-Howard S, Child W, Battanni K, Wang MQ. Oral health literacy and dental care among low-income pregnant women. *Am J Health Behav.* 2019;43(3):556-568.
16. Seymour B, Yang H, Getman R, Barrow J, Kalendarian E. Patient-Centered Communication: Exploring the Dentist's Role in the Era of e-Patients and Health 2.0. *J Dent Educ.* 2016;80(6):697-704.

17. Carey J, Madill A, Manogue M. Communications skills in dental education: A systematic research review. *Eur J Dent Educ*. 2010;14(2):69-78.
18. Yoshida T, Milgrom P, Coldwell S. How do U.S. and Canadian dental schools teach interpersonal communication skills? *J Dent Educ*. 2002;66(11):1281-1288.
19. Laurence B, Bertera EM, Feimster T, Hollander R, Stroman C. Adaptation of the communication skills attitude scale (CSAS) to dental students. *J Dent Educ*. 2012;76(12):1629-1638.
20. Anderson CN, Noar SM, Rogers BD. The persuasive power of oral health promotion messages: A Theory of Planned Behavior approach to dental checkups among young adults. *Health Commun*. 2013;28(3):304-313.
21. Marinho V, Worthington H, Walsh T, Clarkson J. Fluoride varnishes for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev*. 2013;(7):Art. No.: CD002279.
22. Ahovuo-Saloranta A, Forss H, Walsh T, Nordblad A, Mäkelä M, Worthington H. Pit and fissure sealants for preventing dental decay in permanent teeth (Review). *Cochrane Database Syst Rev*. 2017;(7):Art. No.: CD001830.
23. Wright JT, Crall JJ, Fontana M, et al. Evidence-based clinical practice guideline for the use of pit-and-fissure sealants. *J Am Dent Assoc*. 2016;147(8):672-682.e12.
24. Crystal YO, Marghalani AA, Ureles SD, et al. Use of silver diamine fluoride for dental caries management in children and adolescents, including those with special health care needs. *Pediatr Dent*. 2017;39(5):135-145.

25. Weyant RJ, Tracy SL, Anselmo T, et al. Topical fluoride for caries prevention. *J Am Dent Assoc.* 2013;144(11):1279-1291.
26. Institute of Medicine. *Oral Health Literacy: Workshop Summary.* Washington DC: National Academies Press; 2013.
27. American Dental Association. ADA Resolution 14H-2006. <https://www.dentalcare.com/en-us/professional-education/ce-courses/ce335/the-dental-profession-s-response>. Published 2006. Accessed February 3, 2020.
28. Commission on Dental Accreditation. Accreditation Standards for Dental Education Programs. www.ada.org/coda. Published 2019. Accessed February 2, 2020.
29. National Institute of Dental and Craniofacial Research. The invisible barrier: literacy and its relationship with oral health. A report of a workgroup sponsored by the National Institute of Dental and Craniofacial Research, National Institute of Health, U.S. Public Health Service, Department of Health and Huma. *J Public Health Dent.* 2005;65(3):174-182.
30. Kutner M, Greenberg E, Jin Y, Paulsen C. *The Health Literacy of America's Adults: Results from the 2003 National Assessment of Adult Literacy.* Vol 6.; 2006. Available at: <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2006483>. Accessed February 10, 2020.
31. Horowitz AM, Kleinman DV. Oral health literacy: The new imperative to better oral health. *Dent Clin North Am.* 2008;52(2):333-344.

32. Horowitz AM, Kleinman DV, Child W, Maybury C. Perspectives of Maryland adults regarding caries prevention. *Am J Public Health*. 2015;105(5):e58-e64.
33. Horowitz AM, Kleinman DV, Wang MQ. What Maryland adults with young children know and do about preventing dental caries. *Am J Public Health*. 2013;103(6):69-76.
34. Ueno M, Takeuchi S, Oshiro A, Kawaguchi Y. Relationship between oral health literacy and oral health behaviors and clinical status in Japanese adults. *J Dent Sci*. 2013;8(2):170-176.
35. White S, Chen J, Atchison R. Relationship of preventive health practices and health literacy: A national study. *Am J Health Behav*. 2008;32(3):227-242.
36. Wehmeyer MM, Corwin CL, Guthmiller JM, Lee JY. The impact of oral health literacy on periodontal health status. *J Public Health Dent*. 2014;74(1):80-87.
37. Holtzman JS, Atchison KA, Macek MD, Markovic D. Oral Health Literacy and Measures of Periodontal Disease. *J Periodontol*. 2017;88(1):78-88.
38. Holtzman JS, Atchison KA, Gironda MW, Radbod R, Gornbein J. The association between oral health literacy and failed appointments in adults attending a university-based general dental clinic. *Community Dent Oral Epidemiol*. 2014;42(3):263-270.
39. Institute of Medicine and National Research Council. *Improving Access to Oral Health Care for Vulnerable and Underserved Populations*. Washington, DC; 2011. Available at: <http://www.nap.edu/catalog/13116>. Accessed February 02, 2020

40. Ismail AI, Tellez M, Pitts NB, et al. Caries management pathways preserve dental tissues and promote oral health. *Community Dent Oral Epidemiol.* 2013;41(1):12-40.
41. Slayton RL, Urquhart O, Araujo MWB, et al. Evidence-based clinical practice guideline on nonrestorative treatments for carious lesions: A report from the American Dental Association. *J Am Dent Assoc.* 2018;149(10):837-849.e19.
42. Ekstrand KR, Gimenez T, Ferreira FR, Mendes FM, Braga MM. The International Caries Detection and Assessment System - ICDAS: A Systematic Review. *Caries Res.* 2018;52(5):406-419.
43. Featherstone JDB, Chaffee BW. The Evidence for Caries Management by Risk Assessment (CAMBRA®). *Adv Dent Res.* 2018;29(1):9-14.
44. Frencken JE, Manton D, Leal S, Gordan V, Eden E. Minimal intervention dentistry (MID) for managing caries - a review: Report of a FDI task group. *Int Dent J.* 2012;62(5):223-243.
45. Fontana M, Guzmán-Armstrong S, Schenkel AB, et al. Development of a core curriculum framework in cariology for U.S. dental schools. *J Dent Educ.* 2016;80(6):705-720.
46. Haden NK, Hendricson WD, Kassebaum DK, et al. Curriculum change in dental education, 2003-09. *J Dent Educ.* 2010;74(5):539-557.
47. Lanning SK, Brickhouse TH, Gunsolley JC, Ranson SL, Willett RM. Communication skills instruction: An analysis of self, peer-group, student instructors and faculty assessment. *Patient Educ Couns.* 2011;83(2):145-151.

48. Wagner J, Arteaga S, D'Ambrosio J, et al. A patient-instructor program to promote dental students' communication skills with diverse patients. *J Dent Educ.* 2007;71(12):1554-1560.
49. Broder H, Janal M. Promoting interpersonal skills and cultural sensitivity among dental students. *J Dent Educ.* 2006;70(4):409-416.
50. Hottel T, Hardigan P. Improvement in the interpersonal communication skills of dental students. *J Dent Educ.* 2005;69(2):281-284.
51. Oakley M, Horvath Z, Weinberg SM, Bhatt J, Spallek H. Comparison of e-mail communication skills among first- and fourth-year dental students. *J Dent Educ.* 2013;77(11):1413-1424.
52. McKenzie CT. Dental student attitudes towards communication skills instruction and clinical application. *J Dent Educ.* 2014;78(10):1388-1396.
53. McKenzie CT. Instructor and dental student perceptions of clinical communication skills via structured assessments. *J Dent Educ.* 2016;80(5):563-568.
54. Aalboe JA, Schumacher MM. An instrument to measure dental students' communication skills with patients in six specific circumstances: An exploratory factor analysis. *J Dent Educ.* 2016;80(1):58-64.
55. Wener ME, Schönwetter DJ, Mazurat N. Developing new dental communication skills assessment tools by including patients and other stakeholders. *J Dent Educ.* 2011;75(12):1527-1541.

56. Broder HL, Janal M, Mitnick DM, Rodriguez JY, Sischo L. Communication skills in dental students: New data regarding retention and generalization of training effects. *J Dent Educ*. 2015;79(8):940-948.
57. Cannick GF, Horowitz AM, Garr DR, et al. Use of the OSCE to evaluate brief communication skills training for dental students. *J Dent Educ*. 2007;71(9):1203-1209.
58. Bandura A. *Social Foundations of Thought and Action. A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall; 1986.
59. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. *Psychol Rev*. 1977;84(2):191-215.
60. Ajzen I, Fishbein M. *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Reading, MA: Addison-Wesley; 1975.
61. Rozier RG, Horowitz AM, Podschun G. Dentist-patient communication techniques used in the United States: The results of a national survey. *J Am Dent Assoc*. 2011;142(5):518-530.
62. Maybury C, Horowitz AM, Wang MQ, Kleinman DV. Use of communication techniques by Maryland dentists. *J Am Dent Assoc*. 2013;144(12):1386-1396.
63. Koo LW, Horowitz AM, Radice S, Wang MQ, Kleinman DV. Nurse practitioners' use of communication techniques: Results of a Maryland oral health literacy survey. *PLoS One*. 2016;11(1):1-16.
64. Weatherspoon J, Horowitz AM, Kleinman DV, Wang MQ. The use of recommended communication techniques by Maryland family physicians and pediatricians. *PLoS One*. 2015;10(4):1-16.

65. Horowitz AM, Clovis JC, Wang MQ, Kleinman DV. Use of recommended communication techniques by Maryland dental hygienists. *J Dent Hyg.* 2013;87(4):212-223.
66. American Dental Association. 2016-17 Survey of Dental Education. <http://www.ada.org/en/science-research/health-policy-institute/data-center/dental-education>. Published 2017. Accessed December 10, 2019.
67. American Dental Education Association. *Snapshot of Dental Education 2019-2020*. Washington DC; 2019. Available at: https://www.adea.org/uploadedFiles/ADEA/Content_Conversion_Final/deansbriefing/2019-20_ADEA_Snapshot_of_Dental_Education.pdf. Accessed February 10, 2020
68. U.S. Department of Health and Human Services. *Healthy People 2010*. 2nd ed. Washington DC: US Government Printing Office; 2000.
69. Rimal RN, Lapinski MK. Why health communication is important in public health. *Bull World Health Organ.* 2009;87(4):247.
70. Institute of Medicine (Committee on Quality Health Care). *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: National Academy Press; 2001.
71. Institute of Medicine. *Toward Health Equity and Patient-Centeredness: Integrating Health Literacy, Disparities Reduction, and Quality Improvement: Workshop Summary*. Washington, DC: The National Academies Press; 2009.

72. Mertz EA, Wides C, Kottek A, Calvo JM, Gates PE. Underrepresented Minority Dentists: Quantifying Their Numbers And Characterizing The Communities They Serve. *Health Aff.* 2016;35(12):2190-2199.
73. Ha JF, Longnecker N. Doctor-patient communication: A review. *Ochsner J.* 2010;10(1):38-43.
74. Stewart M. Effective physician-patient communication and health outcomes: a review. *Can Med Assoc J.* 1995;152(9):1423-1433.
75. Arora NK. Interacting with cancer patients: The significance of physicians' communication behavior. *Soc Sci Med.* 2003;57(5):791-806.
76. Schoenthaler A, Kalet A, Nicholson J, Lipkin MJ. Does improving patient-practitioner communication improve clinical outcomes in patients with cardiovascular diseases? A systematic review of the evidence. *Patient Educ Couns.* 2014;96(1):3-12.
77. Epstein RM, Duberstein PR, Fenton JJ, et al. Effect of a patient-centered communication intervention on oncologist-patient communication, quality of life, and health care utilization in advanced cancer: The VOICE randomized clinical trial. *JAMA Oncol.* 2016;10(3):728-740.
78. Levinson W, Lesser CS, Epstein RM. Developing physician communication skills for patient-centered care. *Health Aff.* 2010;29(7):1310-1318.
79. Bredart et al. Doctor-patient communication and satisfaction with care in oncology. *Curr Opin Oncol.* 2005;14(4):351-354.

80. Platt F, Keating KN. Differences in physician and patient perceptions of uncomplicated UTI symptom severity: Understanding the communication gap. *Int J Clin Pract.* 2007;61(2):303-308.
81. Ong L, DeHaes J, Hoos A, Lammes F. Doctor-patient communication: A review of the literature. *Soc Sci Med.* 1995;40(7):903-918.
82. Clever SL, Jin L, Levinson W, Meltzer DO. Does doctor-patient communication affect patient satisfaction with hospital care? Results of an analysis with a novel instrumental variable. *Health Serv Res.* 2008;43(5 P1):1505-1519.
83. Mauksch LB, Dugdale DC, Dodson S, Epstein RM. Relationship, communication, and efficiency in the medical encounter: Creating a clinical model from a literature review. *Arch Intern Med.* 2008;168(13):1387-1395.
84. Cousin G, Mast MS, Roter DL, Hall JA. Concordance between physician communication style and patient attitudes predicts patient satisfaction. *Patient Educ Couns.* 2012;87(2):193-197.
85. Tak H, Ruhnke GW, Shih YCT. The association between patient-centered attributes of care and patient satisfaction. *Patient.* 2015;8(2):187-197.
86. Thom DH, Kravitz RL, Bell RA, Krupat E, Azari R. Patient trust in the physician: Relationship to patient requests. *Fam Pract.* 2002;19(5):476-483.
87. Fiscella K, Meldrum S, Franks P, et al. Patient trust. *Med Care.* 2004;42(11):1049-1055.
88. Haskard-Zolnieriek KB, DiMatteo MR. Physician communication and patient adherence to treatment: A meta-analysis. *Med Care.* 2009;47(8):826-834.

89. Mead N, Bower P. Measuring patient-centredness: A comparison of three observation-based instruments. *Patient Educ Couns*. 2000;39(1):71-80.
90. Stewart M, Brown JB, Donner A, et al. The impact of patient-centered care on outcomes. *J Fam Pract*. 2000;49(9):796-804.
91. Epstein RM, Franks P, Fiscella K, et al. Measuring patient-centered communication in patient-physician consultations: Theoretical and practical issues. *Soc Sci Med*. 2005;61(7):1516-1528.
92. Mead N, Bower P. Patient-centred consultations and outcomes in primary care: A review of the literature. *Patient Educ Couns*. 2002;48(1):51-61.
93. Yedidia MJ, Gillespie CC, Kachur E, et al. Effect of communications training on medical student performance. *J Am Med Assoc*. 2003;290(9):1157-1165.
94. Hamilton MA, Rouse RA, Rouse J. Dentist communication and patient utilization of dental services: Anxiety inhibition and competence enhancement effects. *Health Commun*. 1994;6(2):137-158.
95. Griffiths H, Wilson M, Kincey J. Anxiety levels, patient satisfaction & failed appointment rate in anxious patients referred by general practitioners to a dental hospital unit. *Br Dent J*. 1998;185(3):134-136.
96. Levinson W, Roter D, Mullooly J, Dull V, Frankel R. Physician-patient communication: The relationship with malpractice claims among primary care physicians and surgeons. *J Am Med Assoc*. 1997;277(7):553-559.
97. Armfield JM, Heaton LJ. Management of fear and anxiety in the dental clinic: A review. *Aust Dent J*. 2013;58(4):390-407.

98. Sondell K, Soderfeldt B, Palmqvist S. Dentist-patient communication and patient satisfaction in prosthetic dentistry. *Int J Prosthodont*. 2002;15(1):28-37.
99. Hagihara A, Tarumi K. Doctor and patient perceptions of the level of doctor explanation and quality of patient–doctor communication. *Scand J Caring Sci*. 2006;20(2).
100. Hannah A, Millichamp CJ, Ayers KMS. A communication skills course for undergraduate dental students. *J Dent Educ*. 2004;68(9):970-977.
101. Ratzan SC, Parker RM. National Library of Medicine Current Bibliographies in Medicine: Health Literacy. In: Zorn M, C. RS, Parker RM, eds. Bethesda: National Institutes of Health, U.S. Department of Health and Human Services; 2000. Available at:
<https://www.nlm.nih.gov/archive/20061214/pubs/cbm/hliteracy.html#10>. Accessed February 10, 2020.
102. Williams M, Baker DW, Parker RM, Nurss J. Relationship of functional health literacy to patients’ knowledge of their chronic disease: A study of patients with hypertension and diabetes. *Arch Intern Med*. 1998;158(2):166-172.
103. Sanders L, Shaw J, Guez G, Baur C, Rudd R. Health literacy and child health promotion: Implications for research, clinical care, and public policy. *Pediatrics*. 2009;124(Supplement):S306-S314.
104. Schillinger D, Machtinger E, Wang F, Rodriguez M, Bindman A. Preventing medication errors in ambulatory care: The importance of establishing regimen concordance. In: Henriksen K, Battles JB, Marks ES, et al. E, ed. *Advances in Patient Safety: From Research to Implementation (Volume 1: Research*

- Findings*). Rockville: Agency for Healthcare Research and Quality; 2005.
- Available at: <https://www.ncbi.nlm.nih.gov/books/NBK20463/>. Accessed February 10, 2020.
105. Griffey RT, Kennedy SK, McGownan L, Kaphingst KA. Is low health literacy associated with increased emergency utilization and recidivism? *Acad Emerg Med*. 2014;21(10):1109-1115.
 106. Baker DW, Gazmararian JA, Williams MV, et al. Functional health literacy and the risk of hospital admission among Medicare managed care enrollees. *Am J Public Health*. 2002;92(8):1278-1283.
 107. Sudore RL, Yaffe K, Satterfield S, et al. Limited literacy and mortality in the elderly: The health, aging, and body composition study. *J Gen Intern Med*. 2006;21(8):806-812.
 108. Bostock S, Steptoe A. Association between low functional health literacy and mortality in older adults: Longitudinal cohort study. *BMJ*. 2012;344(3):e1602.
 109. DeWalt D, Callahan L, Hawk V, et al. Health Literacy Universal Precautions Toolkit. AHRQ Publication. <https://www.ahrq.gov/professionals/quality-patient-safety/quality-resources/tools/literacy-toolkit/index.html>. Published 2010. Accessed February 10, 2020.
 110. Schwartzberg J, VanGeest J, Want CC, et al., eds. *Understanding Health Literacy: Implications for Medicine and Public Health*. Washington DC: American Medical Association Press; 2005.

111. Davis T. Health Literacy: Hidden Barriers and Practical Strategies. Agency for Healthcare Research & Quality. <http://www.ahrq.gov/professionals/quality-patient-safety/quality-resources/tools/literacy-toolkit/tool3a/index.html>. Published 2015. Accessed February 20, 2020.
112. Katz MG, Jacobson TA, Veledar E, Kripalani S. Patient literacy and question-asking behavior during the medical encounter: A mixed-methods analysis. *J Gen Intern Med*. 2007;22(6):782-786.
113. Dye BA, Tan S, Smith V, et al. Trends in oral health status: United States, 1988-1994 and 1999-2004. *Vital Heal Stat*. 2007;Series 11(248):1-92.
114. U.S. Department of Health and Human Services. *Oral Health in America: A Report of the Surgeon General*. Rockville; 2000. Available at: <https://www.nidcr.nih.gov/DataStatistics/SurgeonGeneral/Documents/hck1ocv.@www.surgeon.fullrpt.pdf>. Accessed February 10, 2020.
115. Dye BA, Li X, Thornton-Evans G. Oral health disparities as determined by selected Healthy People 2020 oral health objectives for the United States, 2009-2010. *Natl Cent Heal Stat Data Br*. 2012;(104):1-8.
116. Schönwetter DJ, Wener ME, Mazurat N. Determining the validity and reliability of clinical communication assessment tools for dental patients and students. *J Dent Educ*. 2012;76(10):1276-1290.
117. Atchison KA, Gironda MW, Messadi D, Der-Martiosian C. Screening for oral health literacy in an urban dental clinic. *J Public Health Dent*. 2010;70(4):269-275.

118. Parker RM, Gazmararian JA. Health literacy: Essential for health communication. *J Health Commun.* 2003;8(Suppl 1):116-118.
119. Gong DA, Lee JY, Rozier RG, Pahel BT, Richman JA, Vann Jr WF. Development and testing of the Test of Functional Health Literacy in Dentistry (TOFHLiD). *J Public Health Dent.* 2007;67(2):105-112.
120. Sabbahi DA, Lawrence HP, Limeback H, Rootman I. Development and evaluation of an oral health literacy instrument for adults. *Community Dent Oral Epidemiol.* 2009;37(5):451-462.
121. Schwartzberg J, Cowett A, VanGeest J, Wolf M. Communication techniques for patients with low health literacy: A survey of physicians, nurses, and pharmacists. *Am J Health Behav.* 2007;31(Suppl 1):S96-S104.
122. American Association of Dental Schools. Curriculum guidelines for behavioral sciences in dentistry. *J Dent Educ.* 1984;48(9):520-526.
123. Centore L. Trends in behavioral sciences education in dental schools, 1926-2016. *J Dent Educ.* 2017;81(8s):e66-es74.
124. American Association of Dental Schools. Curriculum guidelines for behavioral science. *J Dent Educ.* 1993;57(8):648-657.
125. Institute of Medicine. *Dental Education at the Crossroads: Challenges and Change.* (Field MJ, ed.). Washington, DC: The National Academies Press; 1995.
126. U.S. Department of Health and Human Services. *A National Call To Action to Promote Oral Health: A Public-Private Partnership.* Rockville, MD; 2003.

127. American Dental Association. 2006 Transactions. Chicago, IL; 2006.
128. American Dental Association. *2008 Transactions*. Chicago, IL; 2008.
129. American Dental Association Council on Access, Prevention and Interprofessional Relations. *Health Literacy in Dentistry Action Plan 2010-2015*. Chicago, IL; 2009.
130. ADEA House of Delegates. ADEA competencies for the new general dentist. *J Dent Educ*. 2015;75(7):813-816.
131. Ayn C, Robinson L, Nason A, Lovas J. Determining recommendations for improvement of communication skills training in dental education - scoping review. *J Dent Educ*. 2017;81(4):479-488.
132. Kalet A, Pugnaire M, Cole-Kelly K, et al. Teaching communication in clinical clerkships: Models from the Macy initiative in health communications. *Acad Med*. 2004;79(6):511-520.
133. Kurtz S, Silverman J. The Calgary-Cambridge Referenced Observation Guides: An aid to defining the curriculum and organizing the teaching in communication training programmes. *Med Educ*. 1996;30(2):83-89.
134. Haak R, Rosenbohm J, Koerfer A, Obliers R, Wicht M. The effect of undergraduate education in communication skills: A randomised controlled clinical trial. *Eur J Dent Educ*. 2008;12(4):213-218.
135. Kramer GA, Albino JEN, Andrieu SC, et al. Dental student assessment toolbox. *J Dent Educ*. 2009;73(1):12-35.
136. Krupat E, Frankel R, Stein T, Irish J. The Four Habits Coding Scheme: Validation of an instrument to assess clinicians' communication behavior.

- Patient Educ Couns.* 2005;62(1):38-45.
137. Stein T, Frankel RM, Krupat E. Enhancing clinician communication skills in a large healthcare organization: A longitudinal case study. *Patient Educ Couns.* 2005;58(1):4-12.
138. Featherstone J. Dental caries: A dynamic disease process. *Aust Dent J.* 2008;53(3):286-291.
139. National Institutes of Health. *Diagnosis and Management of Dental Caries Throughout Life: NIH Consensus Statement.* Bethesda, MD; 2001.
<https://consensus.nih.gov/2001/2001DentalCaries115PDF.pdf>.
140. Fontana M, Wolff M. Translating the caries management paradigm into practice: Challenges and opportunities. *J Calif Dent Assoc.* 2011;39(10):702-708.
141. Wright JT, Crall JJ, Fontana M, et al. Evidence-based clinical practice guideline for the use of pit-and-fissure sealants: A report of the American Dental Association and the American Academy of Pediatric Dentistry. *J Am Dent Assoc.* 2016;147(8):672-682.e12.
142. American Dental Association. Silver Diamine Fluoride in Caries Management. <http://www.ada.org/en/science-research/science-in-the-news/silver-diamine-fluoride-in-caries-management>. Published 2016. Accessed February 10, 2020.
143. Tyas MJ, Anusavice KJ, Frencken JE, Mount GJ. Minimal intervention dentistry - A review: FDI Commission Project 1-97. *Int Dent J.* 2000;50(1):1-12.

144. Beauchamp J, Caufield PW, Crall JJ, et al. Evidence-based clinical recommendations for the use of pit-and-fissure sealants. *J Am Dent Assoc.* 2008;139(3):257-268.
145. Allan J, Barwick TA, Cashman S, et al. Clinical prevention and population health: Curriculum framework for health professions. *Am J Prev Med.* 2004;27(5):471-476.
146. Formicola A. Trends in Dental Faculty of U.S. Dental Schools, 2003-04 to 2013-14. *J Dent Educ.* 2017;81(8s):33-40.
147. Brown JP. A new curriculum framework for clinical prevention and population health, with a review of clinical caries prevention teaching in U.S. and Canadian dental schools. *J Dent Educ.* 2007;71(5):572-578.
148. Young DA, Featherstone JDB. Caries management by risk assessment. *Community Dent Oral Epidemiol.* 2013;41(1):53-63.
149. Chaffee BW, Featherstone JDB. Long-term adoption of caries management by risk assessment among dental students in a university clinic. *J Dent Educ.* 2015;79(5):539-547.
150. Fontana M, Zero D. Bridging the gap in caries management between research and practice through education: the Indiana University experience. *J Dent Educ.* 2007;71(5):579-591.
151. Rechmann P, Chaffee B, Rechmann B, Featherstone J. Caries management by risk assessment: results from a practice-based research network study. *J Calif Dent Assoc.* 2019;47(1):15-24.

152. Autio-Gold JT, Tomar SL. Dental students' opinions and knowledge about caries management and prevention. *J Dent Educ.* 2008;72(1):26-32.
153. American Dental Association. Tooth. <http://www.mouthhealthy.org/en/az-topics/t/tooth>. Published 2017. Accessed January 2, 2020.
154. Centers for Disease Control and Prevention. U.S. Public Health Service Recommendation for Fluoride Concentration in Drinking Water for the Prevention of Dental Caries. *Public Health Rep.* 2015;130(1):318-331.
155. Featherstone J. Prevention and reversal of dental caries: Role of low level fluoride. *Community Dent Oral Epidemiol.* 1999;27(31-40).
156. Koulourides T. Summary of session II: Fluoride and the caries process. *J Dent Res.* 1990;69(Special Issue):558.
157. Centers for Disease Control and Prevention (CDC). *Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States*; 2001. Available: at:
<https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5014a1.htm>. Accessed February 10, 2010.
158. Featherstone JD. The science and practice of caries prevention. *J Am Dent Assoc.* 2000;131(7):887-899.
159. Centers for Disease Control and Prevention. Water Fluoridation Basics.
<https://www.cdc.gov/fluoridation/basics/index.htm>. Published 2016. Accessed February 25, 2018.
160. Griffin SO, Regnier E, Griffin PM, Huntley V. Effectiveness of fluoride in preventing caries in adults. *J Dent Res.* 2007;86(5):410-415.

161. Centers for Disease Control and Prevention (CDC). *Achievements in Public Health, 1900-1999: Fluoridation of Drinking Water to Prevent Dental Caries.*; 1999. Available at :

<https://www.cdc.gov/mmwr/preview/mmwrhtml/mm4841a1.htm>. Accessed February 10, 2020.
162. Riley JC, Lennon MA, Ellwood RP. The effect of water fluoridation and social inequalities on dental caries in 5-year-old children. *Int J Epidemiol.* 1999;28(2):300-5.
163. Dye BA, Li X, Beltran-Aguilar ED. Selected oral health indicators in the United States, 2005-2008. *NCHS Data Brief.* 2012;(96):1-8.
164. Dye BA, Thornton-Evans G, Li X, Iafolla TJ. Dental caries and sealant prevalence in children and adolescents in the United States, 2011-2012. *NCHS Data Brief.* 2015;(191):1-8.
165. National Center for Health Statistics. *Health, United States, 2016: With Chartbook on Long-Term Trends in Health. Table 60: Untreated Dental Caries, by Selected Characteristics: United States, Selected Years 1988-1994 through 2011-2014.* Hyattsville, MD.; 2017.
166. Çolak H, Dülgergil Ç, Dalli M, Hamidi M. Early childhood caries update: A review of causes, diagnoses, and treatments. *J Nat Sci Biol Med.* 2013;4(1):29.
167. Casamassimo P, Thikkurissy S, Edelstein B, Maiorini E. Beyond the dmft: The human and economic cost of early childhood caries. *J Am Dent Assoc.* 2009;140(6):650-657.

168. Griffin SO, Jones JA, Brunson D, Griffin PM, Bailey WD. Burden of oral disease among older adults and implications for public health priorities. *Am J Public Health.* 2012;102(3):411-418.
169. Jackson SL, Vann Jr WF, Kotch JB, Pahel BT, Lee JY. Impact of poor oral health on children's school attendance and performance. *Am J Public Health.* 2011;101(10):1900-1906.
170. Gift H, Reisine S, Larach D. The social effects of dental problems. *Am J Public Health.* 1992;82(12):1663-1668.
171. Listl S, Galloway J, Mossey P, Marcenes W. Global economic impact of dental diseases. *J Dent Res.* 2015;94(10):1355-1361.
172. Birch S. Paying for prevention in clinical practice: Aligning provider remuneration with system objectives. *BMC Oral Health.* 2015;15(1):S7.
173. Niederman R, Huang SS, Trescher AL, Listl S. Getting the incentives right: Improving oral health equity with universal school-based caries prevention. *Am J Public Health.* 2017;107:S50-S55.
174. Griffin S, Gooch B, Beltrán E, Sutherland J, Barsley R. Dental services, costs, and factors associated with hospitalization for Medicaid-eligible children, Louisiana 1996–97. *J Public Health Dent.* 2000;60(1):21-27.
175. Dye BA, Nowjack-Raymer R, Barker L, et al. Overview and quality assurance for the oral health component of the National Health and Nutrition Examination Survey (NHANES), 2003-04. *J Public Health Dent.* 2008;68(4):218-226.

176. Seppä L. Fluoride varnishes in caries prevention. *Med Princ Pract*. 2004;13(6):307-311.
177. Zimmer S, Robke FJ, Roulet JF. Caries prevention with fluoride varnish in a socially deprived community. *Community Dent Oral Epidemiol*. 1999;27(2):103-108.
178. Autio-Gold J, Courts F. Assessing the effect of fluoride varnish on early enamel carious lesions in the primary dentition. *J Am Dent Assoc*. 2001;132:1247-1253.
179. Association of State and Territorial Dental Directors (ASTDD). Fluoride Varnish: An Evidence-based Approach Research Brief. Available at: <https://www.astdd.org/docs/Sept2007FINALFlvarnishpaper.pdf>. Published 2007. Accessed February 1, 20120
180. American Dental Association Council on Scientific Affairs. Professionally applied topical fluoride. *J Am Dent Assoc*. 2006;137(8):1151-1159.
181. Moyer V. Prevention of dental caries in children from birth through age 5 years: US Preventive Services Task Force Recommendation Statement. *Pediatrics*. 2014;133(6):1102-1111.
182. Beltrán-Aguilar ED, Barker L, Dye BA. *Prevalence and Severity of Dental Fluorosis in the United States, 1999-2004*. Hyattsville, MD.; 2010. Available at: <http://www.ncbi.nlm.nih.gov/pubmed/21211168>. Accessed February 10, 2020.
183. American Academy of Pediatric Dentistry. Guideline on Fluoride Therapy. *Pediatr Dent*. 2014;37(6):176-179.

184. Rosenblatt A, Stamford T, Niederman R. Silver diamine fluoride: A caries “silver-fluoride bullet.” *J Dent Res*. 2009;88(2):116-125.
185. Association of State and Territorial Dental Directors (ASTDD). Silver Diamine Fluoride (SDF) Fact Sheet. <http://www.astdd.org/www/docs/sdf-fact-sheet-09-07-2017.pdf>. Published 2017. Accessed January 2, 2020.
186. Contreras V, Toro MJ, Eliás-Boneta AR, Encarnación-Burgos A. Effectiveness of silver diamine fluoride in caries prevention and arrest: A systematic literature review. *Gen Dent*. 2017;65(3):22-29.
187. Llodra J, Rodriguez A, Ferrer B, Menardia V, Ramos T, Morato M. Efficacy of silver diamine fluoride for caries reduction in primary teeth and first permanent molars of schoolchildren: 36-month clinical trial. *J Dent Res*. 2005;84(8):721-724.
188. Mei M, Lo E, Chu C. Clinical use of silver diamine fluoride in dental treatment. *Compend Contin Educ Dent*. 2016;37(2):93-98.
189. Li R, Lo E, Liu B, Wong M, Chu C. Randomized clinical trial on arresting dental root caries through silver diammine fluoride applications in community-dwelling elders. *J Dent Res*. 2016;51:15-20.
190. Zhang W, McGrath C, Lo E, Li J. Silver diamine fluoride and education to prevent and arrest root caries among community-dwelling elders. *Caries Res*. 2013;47(4):284-290.
191. Chu C, Lo E, Lin H. Effectiveness of silver diamine fluoride and sodium fluoride varnish in arresting dentin caries in Chinese pre-school children. *J Dent Res*. 2002;81:767-770.

192. Gao SS, Zhang S, Mei ML, Lo ECM, Chu CH. Caries remineralisation and arresting effect in children by professionally applied fluoride treatment - A systematic review. *BMC Oral Health*. 2016;16(1):1-9.
193. Nagarkar S, Kumar J, Moss M. Early childhood caries–related visits to emergency departments and ambulatory surgery facilities and associated charges in New York state. *J Am Dent Assoc*. 2012;143(1):59-65.
194. Hicks C, Jones J, Saxen M. Demand in pediatric dentistry for sedation and general anesthesia by dentist anesthesiologists: A survey of directors of dentist anesthesiologist and pediatric dentistry residencies. *Anesth Prog*. 2012;59(1):3-011.
195. Schroth RJ, Quiñonez C, Shwart L, Wagar B. Treating early childhood caries under general anesthesia: A national review of Canadian data. *J Can Dent Assoc (Tor)*. 2016;82:1-8.
196. Liu J, Probst JC, Martin AB, Wang JY, Salinas CF. Disparities in dental insurance coverage and dental care among US children: The National Survey of Children’s Health. *Pediatrics*. 2007;119 Suppl:S12-21.
197. American Dental Association. Sealants. <http://www.mouthhealthy.org/en/az-topics/s/sealants>. Published 2017. Accessed January 2, 2020.
198. Weintraub J, Stearns S, Rozier RG, Huang C. Treatment outcomes and costs of dental sealants among children enrolled in Medicaid. *Am J Public Health*. 2001;91(11):1877-1881.

199. Bhuridej P, Kuthy R, Flach S, et al. Four-year cost-utility analyses of sealed and nonsealed first permanent molars in Iowa Medicaid-enrolled children. *J Public Health Dent.* 2007;67(4):191-198.
200. Azarpazhooh A, Main P. Is there a risk of harm or toxicity in the placement of pit and fissure sealant materials? A systematic review. *J Can Dent Assoc (Tor).* 2008;74(2):179-183.
201. Liu B, Lo E, Chu C, Lin H. Randomized trial on fluorides and sealants for fissure caries prevention. *J Dent Res.* 2012;91(8):753-758.
202. O'Donnell JA, Modesto A, Oakley M, Polk DE, Valappil B, Spallek H. Sealants and dental caries: Insight into dentists' behaviors regarding implementation of clinical practice recommendations. *J Am Dent Assoc.* 2013;144(4):e24-30.
203. Chi DL, Singh J. Reimbursement rates and policies for primary molar pit-and-fissure sealants across state Medicaid programs. *J Am Dent Assoc.* 2013;144(11):1272-1278.
204. Chi DL, Van Der Goes DN, Ney JP. Cost-effectiveness of pit-and-fissure sealants on primary molars in medicaid-enrolled children. *Am J Public Health.* 2014;104(3):555-561.
205. Community Preventive Services Task Force. *Dental-Caries-Cavities-School-Based-Dental-Sealant-Delivery-Programs @ Wwww.Thecommunityguide.Org.*; 2013. Available at: <https://www.thecommunityguide.org/findings/dental-caries-cavities-school-based-dental-sealant-delivery-programs>. Accessed January 02, 2020.

206. Oxman A, Thomson M, Davis D, Haynes B. No magic bullets: a systematic review of 102 trials of interventions to improve professional practice. *Can Med Assoc J.* 1995;153(10):1423-1431.
207. Ajzen I. From Intentions to Actions: A Theory of Planned Behavior. In: Kuhl J, Beckman J, eds. Heidelberg: Springer; 1985:11-39.
208. Ajzen I. *The Theory of Planned Behavior.* Vol 50.; 1991.
209. Fishbein M, Ajzen I. *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research.* Reading, MA: Addison-Wesley; 1975.
210. Mann K V. Theoretical perspectives in medical education: Past experience and future possibilities. *Med Educ.* 2011;45(1):60-68.
211. Kenny N, Mann K, MacLeod H. Role modeling in physicians professional formation: Reconsidering an essential but untapped educational strategy. *Acad Med.* 2003;78(12):1203-1210.
212. Torre D, Durning S. Social Cognitive Theory: Thinking and Learning in Social Settings. In: Cleland J, Durning SJ, eds. *Researching Medical Education.* Chichester, UK.: John Wiley & Sons, Ltd.; 2015:105-116.
213. Godin G, Bélanger-Gravel A, Eccles M, Grimshaw J. Healthcare professionals' intentions and behaviours: A systematic review of studies based on social cognitive theories. *Implement Sci.* 2008;3:36.
214. Eccles MP, Grimshaw JM, MacLennan G, et al. Explaining clinical behaviors using multiple theoretical models. *Implement Sci.* 2012;7(1):99.
215. Walker AE, Grimshaw J, Johnston M, Pitts N, Steen N, Eccles M. PRIME - PRocess modelling in ImpleMEntation research: Selecting a theoretical basis

- for interventions to change clinical practice. *BMC Health Serv Res.* 2003;3(1):22.
216. Blackman D. *Operant Conditioning: An Experimental Analysis of Behaviour*. London: Methuen; 1974.
 217. Gollwitzer P. Goal achievement: the role of intentions. In: Stroebe W, Hewstone M, eds. *European Review of Social Psychology*. Chichester, UK: Wiley; 1993:141–185.
 218. Leventhal H, Nerenz D, Steele D. *Handbook of Psychology and Health*. New Jersey: Lawrence Erlbaum; 1984.
 219. DiClemente CC, Prochaska JO. Self-change and therapy change of smoking behavior: A comparison of processes of change in cessation and maintenance. *Addict Behav.* 1982;7(2):133-142.
 220. Bonetti D, Pitts NB, Eccles M, et al. Applying psychological theory to evidence-based clinical practice: Identifying factors predictive of taking intra-oral radiographs. *Soc Sci Med.* 2006;63(7):1889-1899.
 221. Bonetti D, Johnston M, Clarkson J, Turner S. Applying multiple models to predict clinicians' behavioural intention and objective behaviour when managing children's teeth. *Psychol Health.* 2009;24(7):843-860.
 222. Bonetti D, Eccles M, Johnston M, et al. Guiding the design and selection of interventions to influence the implementation of evidence-based practice: An experimental simulation of a complex intervention trial. *Soc Sci Med.* 2005;60:2135–2147.

223. Kaufman, DM and Mann K. Teaching and learning in medical education: How theory can inform practice. In: Swanick T, ed. *Understanding Medical Education: Evidence, Theory and Practice*. Second. John Wiley & Sons, Ltd.; 2010:7-29.
224. Eccles M, Grimshaw J, Walker A, Johnston M, Pitts N. Changing the behavior of healthcare professionals: The use of theory in promoting the uptake of research findings. *J Clin Epidemiol*. 2005;58(2):107-112.
225. Baranowski T, Perry CL, Parcel GS. How individuals, environments and health behavior interact. In: Glanz K, Lewis FM, Rimer BK, eds. *Health Behavior and Health Education: Theory, Research, and Practice*. 3rd ed. San Francisco: Jossey-Bass; 2002:165-184.
226. Cervone D, Shadel W, Jencius S. Social-cognitive theory of personality assessment. *Personal Soc Psychol Rev*. 2001;5(1):33-51.
227. Featherstone J. The caries balance: The basis for caries management by risk assessment. *Oral Heal Prev Dent*. 2004;2(Suppl 1):1259-1264.
228. Brach C, Keller D, Hernandez L, et al. *Ten Attributes of Health Literate Health Care Organizations*.; 2012. Available at: http://iom.edu/~media/Files/Perspectives-Files/2012/Discussion-Papers/BPH_Ten_HLit_Attributes.pdf. Accessed February 02, 2020.
229. Horowitz AM, Maybury C, Kleinman D V., et al. Health literacy environmental scans of community-based dental clinics in maryland. *Am J Public Health*. 2014;104(8):85-93.

230. Cronbach L. Coefficient alpha and the internal structure of tests. *Psychometrika*. 1951;16:297-334.
231. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. (Associates. LE, ed.). Hillsdale, New Jersey; 1988.
232. Olabi NF, Jones JE, Saxen M a, et al. The use of office-based sedation and general anesthesia by board certified pediatric dentists practicing in the United States. *Anesth Prog*. 2012;59(1):12-17.
233. Goodchild J, Donaldson M. The use of sedation in the dental outpatient setting: A web-based survey of dentists. *Dent Implantol Update*. 2011;22(11):73-80.
234. Hardigan P, Succar C, Fleisher J. An analysis of response rate and economic costs between mail and web-based surveys among practicing dentists: a randomized trial. *J Community Health*. 2012;37(2):383-394.
235. Cunningham CT, Quan H, Hemmelgarn B, et al. Exploring physician specialist response rates to web-based surveys. *BMC Med Res Methodol*. 2015;15(1):32.
236. Funkhouser E, Fellows JL, Gordan VV, Rindal B, Foy PJ, Gilbert GH. The National Dental PBRN. *J Public Health Dent*. 2014;74(4):276-282.
237. Qualtrics XM [Computer Software]. 2019. <https://www.qualtrics.com/>.
238. Lomax RG, Hahs-Vaughn D. *Statistical Concepts A Second Course*. 4th ed. New York: Routledge Taylor Francis Group; 2012.
239. Graham JW. Missing data analysis: Making it work in the real world. *Annu Rev Psychol*. 2009;60(1):549-576.
240. Schafer JL, Graham JW. Missing data: Our view of the state of the art. *Psychol Methods*. 2002;7(2):147-177.

241. Lomax RG, Hahs-Vaughn D. *An Introduction to Statistical Concepts*. 3rd ed. New York: Routledge Taylor Francis Group; 2012.
242. IBM Corp. IBM SPSS Statistics for Windows, version 25.
243. American Dental Association. About the ADA. <http://www.ada.org/en/about-the-ada>. Published 2017. Accessed October 10, 2017.
244. American Dental Association. ADA council gets renamed. <https://www.ada.org/en/publications/ada-news/2016-archive/november/ada-council-gets-renamed>. Published 2016. Accessed February 7, 2020.
245. American Dental Association. Health Policy Institute. <https://www.ada.org/en/science-research/health-policy-institute>. Accessed February 7, 2020.
246. American Dental Education Association. About ADEA. http://www.adea.org/about_adea/Pages/default.aspx. Published 2017. Accessed October 10, 2017.
247. American Student Dental Association. About ASDA. <https://www.asdanet.org/about-asda>. Accessed February 7, 2020.
248. Commission on Dental Accreditation. Establishment of the Commission. <http://www.ada.org/en/coda/accreditation/about-us>. Published 2017. Accessed February 02, 2020.
249. Roberson T, Heymann H, Swift Jr E, Sturdevant C. *Sturdevant's Art and Science of Operative Dentistry*. St. Louis: Mosby; 2006.

250. Sicca C, Bobbio E, Quartuccio N, Nicolò G, Cistaro A. Prevention of dental caries: A review of effective treatments. *J Clin Exp Dent*. 2016;8(5):e604-e610.
251. Featherstone JDB, Domejean-Orliaguet S, Jenson L, Wolff M, Young DA. Caries risk assessment in practice for age 6 through adult. *J Calif Dent Assoc*. 2007;35(10):703-713.
252. Hunter P. Risk factors in dental caries. *Int Dent J*. 1988;38(4):211-217.
253. Mount GJ. Defining, classifying, and placing incipient caries lesions in perspective. *Dent Clin North Am*. 2005;49(4):701-723.
254. Splieth C, Forster M, Meyer G. Additional caries protection by sealing permanent first molars compared to fluoride varnish applications in children with low caries prevalence: 2-year results. *Eur J Paediatr Dent*. 2001;3:133-137.