The Effects of Mobile Health Applications on Pediatric Dentists' Use of Fluoride Varnish For High-Caries Risk Patients

Gregory Gardner

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Committee:

Zheng Xu

Eric J. Seibel

Joel Berg

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Abstract

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Gregory Gardner

Chair of the Supervisory Committee:
Zheng Xu, DMD, PhD
Department of Pediatric Dentistry, University of Washington

Purpose: To assess the effects of mobile health (mHealth) applications (apps) on the behaviors of pediatric dentists (PDs) regarding the use of 5% sodium fluoride varnish (FV) for the caries management of high-risk pediatric patients.

Methods: An instructional dental mHealth app was developed as the intervention in this cross-sectional study. Two hundred and thirty licensed and actively practicing PDs were solicited to participate in a survey including questions regarding caries management protocols for high caries-risk patients under various scenarios involving at-home FV (AHFV) application. Responding PDs were divided in two randomized groups; one group was exposed to the mHealth app while the control group was not exposed.

Results: A total of 116 PDs who fully completed the survey (50.4% response rate) were included in the study; n=57 for control group, and n=59 for the intervention group. The two groups showed no statistically significant differences regarding distribution by demographics for time in practice

(age), gender, nor primary place of practice. For the age-based scenarios the distribution of PDs willing to give AHFV between control and intervention groups was not statistically significant for any scenario, nor significant overall. However, there was a trend regarding increasing willingness to give AHFV with increasing child age: a) child less than six years old, control n=17, intervention n=18 ($p = 0.94$), b) child between six to 12 years old, control n=20, intervention n=26 ($p = 0.32$), and c) child over 12 years old in braces, control n=26, intervention n=34 ($p = 0.20$). Overall 98.3% of PDs reported using FV on a regular basis, 22.4% stated they had previously given FV for at-home use, and between 29.8-57.6% reported that they would consider dispensing AHFV under various conditions. Additionally, PDs from both groups with a previous history of giving AHFV, male providers, and PDs working part or full-time in private practice were more likely to recommend at-home FV than their corresponding counterparts of no history of at-home FV ($p < 0.001$), female providers ($p = 0.002$), and PDs working 100% of their time in non-private settings, respectively ($p = 0.026$). Time in practice, and previous use of mHealth apps with patients did not show any significance between groups, nor overall.

Conclusions: The results suggest that the presence of technology, such as mHealth apps, have no statistically significant influence on PDs to endorse a protocol outside of their regular routine to manage high-caries risk patients. However, one-fifth of respondents overall have already engaged in providing at-home use FV, and even more are willing to recommend the non-standard therapy. This suggests that PDs may be seeking newer medical model modalities. Ultimately, this study's outcomes are encouraging for the expansion of teledentistry efforts since many PDs are willing to provide alternative, interactive therapies, and gave positive feedback about mHealth patient education efforts. These observations are promising for the addition of new technologies, and for expansion of the medical model within dentistry to treat the disease, not just the symptoms.

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DEDICATION

To my wife and eternal companion Laura, for raising the children, living in sub-standard conditions, following me on my crazy path, keeping me sane, forgiving me, and loving me despite my many shortcomings. Thank you, I love you! Also to my children, Henry, Lily, and Maxwell – daddy's back home from work now!

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Chapter 1. INTRODUCTION

CARIES IN THE U.S.

In the United States from 2015-2016 the prevalence of total dental caries (treated and untreated cavities) for children aged 2-19 years was 45.8% (1). Up to 60% of children have experienced caries by age five, and that number climbs to 78% by the age of 17 (2, 3). Higher caries prevalence is correlated to lower socioeconomic status: 56.3% of youth below the federal poverty level had dental caries compared to 34.8% of children from families with incomes greater than 300% of the poverty level (1). Disparities are further magnified when comparing urban versus rural distributions of dentists per population ratios (4). Rural populations tend to have fewer health-care personnel, lower average incomes, higher caries rates, and be less informed regarding oral health education (4,5,6). Urban living children may have more dental providers within their proximity than rural children, but those of lower income families have similar barriers to optimal oral care as rural populations - except for distance traveled - due to a low proportion of providers that participate in government insurance programs (7,8). It has also been shown repeatedly that children with the greatest level of caries and oral health needs are the same who have the most barriers to oral health care, including distance traveled, other health needs, and low oral health literacy (1,6,7). Federal and state governments have specific goals to improve access to oral health care for these groups, and significant efforts are made to realize these goals (3,7). Newer modalities to reduce caries through prevention and treatment for all children, specifically those with increased barriers to care, include a paradigm shift towards medical management of caries, and teledentistry (9,10,11).

MEDICAL MODEL OF CARIES MANAGEMENT

Evidence-based strategies for caries management are encouraging many dentists to shift from a surgical model of "watching and waiting" until they "drill and fill" to a medical model that treats the disease, not just the symptoms (9,10,12). This new model aims to provide disease management via modification of the biofilm, reduction of cavity-causing bacterial loads, and a range of minimally-invasive medicinal treatments for conservation of tooth structure (13,14). Chemical interventions before mechanical interventions can cut patient costs by preventing progression of caries, reducing the number of dental procedures required to restore carious lesions, and improving longevity of natural teeth (13,14,15). These methods are generally administered under the principal of active surveillance (16). Compared to the annual costs of nearly $119 billion for dental procedures in the U.S. in 2015, and the estimated 34 million school hours missed by children annually for acute dental concerns, medical management by active surveillance can reduce services performed, travel costs, parents' time off work, and children missing days of school (16,17,18). FV is an inexpensive and effective medicinal therapy in this paradigm shift in caries management in high-risk pediatric populations, and is recommended during active surveillance (19).

FLUORIDE VARNISH

FV is typically professionally applied to all exposed teeth surfaces for desensitization, directly to caries lesions for an antimicrobial effect, and for remineralization of enamel (15,20,21). When applied monthly over a six-month period FV has been shown to be effective for treating incipient caries, or white spot lesions (WSL's) of teenagers wearing orthodontic braces (20,22). Typically, the concentration of topically applied fluoride products range from home-use toothpastes at 1100 ppm, to prescription toothpaste at 5,000 ppm, up to professionally applied FV (most commonly

5% sodium fluoride) at 22,500 ppm and silver diamine fluoride (SDF) at 44,800 ppm (15,21). The recommendations for amounts of fluoride used, and delivery methods, vary by age due to safety concerns of toxicity from excessive fluoride exposure and risk of fluorosis (15,23,24).

In 2013 the American Dental Association (ADA) updated clinical recommendations for topical fluoride agents, including professionally-applied varnish (21). Their recommendations for FV use, especially on high-caries risk patients, and children under the age of 6, are based on moderate to low certainty evidence, ranging from "in favor of" to "expert opinion for" levels of support. They also give latitude to providers to use professional judgment in recommending topical fluoride use based on a patient's caries risk, history, and needs – similar to an open-ended expert-opinion-for recommendation (14,21). The use of FV as a caries control therapy is considered an off-label use by the Food & Drug Administration (FDA) (24). Regarding the safety of FV compared to other fluoride modalities the ADA states that "[FV] dispensed in unit doses has lower potential for harm ... because the amount [of fluoride per dose] ... is approximately one-tenth that of other professionally applied products" (21).

The use of FV in the US has been on the rise since it was approved by the FDA in 1994 due to ease of application, preference by many providers and patients, evidence from authoritative research, and the advent of reimbursement to medical providers by many states' Medicaid programs (14,15,19,20,21,25). Nevertheless, the use of FV in dental care may be underwhelming despite the abovementioned support (15). One survey in Indiana in 2005 showed only 2% of responding dentists most often used FV in their offices compared to other topical fluoride products such as acidulated phosphate fluoride gel (26). A similar investigation in Texas in 2012 reported

higher values of 15.7% of general dentists and 30.8% of pediatric dentists saying they use FV routinely; however this still represents a minority of providers (27). Reasons for the relatively low numbers of providers using FV routinely in the office include that FV is one of the newer methods available, and the industry has put huge development efforts into other delivery methods such as rinses, foams, and gels (15). Though FV is a newer modality, six systematic reviews have shown that FV is effective at preventing caries in primary and permanent dentitions when applied between two to four times per year (28). Additionally the International Caries Classification and Management System (ICCMS) recommends FV every three months for high caries-risk patients (29).

TELEDENTISTRY

In addition to using more promising therapies like FV for caries disease management, other modalities to overcome barriers to care include teledentistry, which has been shown to be effective among vulnerable populations (30,31). In 1994, the US Army recognized the potential for teledentistry in its Total Dental Access (TDA) project (32). TDA included a tool to transfer oral pictures and radiographs to remote dentists for evaluation of gum disease. As smartphone use and Internet connectivity have increased, teledentistry tools have expanded for more dental disciplines including general practice, orthodontics, endodontics, oral surgery, periodontics, and public health (30,31). The expansion of technology and applications provides nearly limitless avenues of possibility to enhance or optimize almost every aspect of life. As of 2017 there were more than 325,000 health-related apps available for download (33). Within general dentistry, mHealth apps have primarily been used to promote oral health by providing simple hygiene training instructions, and timers to monitor brushing time (34,35). These apps have little or no support for

communication with the patient's dental provider. Advancements in mHealth have started to include remote diagnosis and monitoring of caries, management of gum disease, and placement of interim restorations by registered dental therapists (30,31,36). Expanding the functions of mid-level providers to additional duties may well open the door for normally in-office therapies to be administered remotely. New caries management protocols enacted within teledentistry could further reduce rates of dental disease, shrink barriers to care, and decrease dental costs (4,7,10,16,30,31).

Most research regarding telehealth analyzes patient adherence and health outcomes (37,38). Few studies have investigated how the presence of mHealth tools might affect the way providers actually choose to practice (39). This study was designed to explore what therapies dental providers might be open to using for the medical management of caries, in combination with an mHealth app that is functional for teledentistry. The affordances of telehealth in coordinating care between home and office can promote collaboration and trust among patients and their health provider, thus might expand the choice of remotely-administered treatments (38,39,40). Specifically, this study's question was: when exposed to an mHealth tool designed for home education and instruction, would providers be more willing to prescribe an alternative, non-standard therapy, such as at-home fluoride varnish (AHFV), for high-caries risk patients?

1.1 OBJECTIVES & HYPOTHESES

Objectives:

1. To investigate the prevalence of PD's in WA who use FV regularly in practice, and have by professional judgment previously recommended FV for at-home use before.
2. To determine whether the presence of an mHealth app has an influence on pediatric dental providers' willingness to recommend AHFV, and under what circumstances they may be so inclined.
3. If there *is* a relationship between technology exposure and a providers' decision for AHFV use, to determine if time in practice, gender, or primary place of practice, or history of mobile health-app use have any predictive effects.

Hypotheses:

H0: Pediatric dentists in WA, when exposed to mHealth tools promoting home care instruction, will NOT be more likely to recommend AHFV for high caries-risk patients.

H1: Pediatric dentists in WA, when exposed to mHealth tools promoting home-care instruction, will be more likely to recommend AHFV for high caries-risk patients compared to colleagues who were not exposed to the apps.

Chapter 2. METHODS

2.1 STUDY DESIGN

In this cross-sectional, split-group survey a beta-version shell of a mobile health application was developed to be the technological tool representing the study intervention. Two hundred and thirty Washington-area PDs were contacted for survey participation, and 116 responded completely and were eligible for inclusion (50.4% response rate). Inclusion criteria were current WA licensure, and to be actively practicing as a pediatric dentist between 2018 and 2019. Participants were recruited by email, over the phone, and in person, then randomly assigned to either be in the intervention group who was exposed to the mHealth app prior to the survey, or to be in the control group who was not exposed. No identifying information was collected in the survey. Randomization was aided by Microsoft Excel's (2016) random number generator, and then both groups were emailed links to identical surveys – with the exception that the intervention group's survey began with a 1 minute 44 second video demonstrating the mHealth app's functions and interaction between provider and patient/parent with minimal bias, and no reference to fluoride varnish . The script for the video is in Appendix 1. The survey data were collected using REDCap (2019). Participation was encouraged by offering a $10 gift card for completion of the survey. Reimbursement funds were provided by an NSF grant: PFI:BIC 11631146 – Oral Health Monitor [PI: Seibel]. Forty-seven of the 116 eligible respondents (40.5%) accepted the gift card, whereas the remainder declined the offer. The study was approved by the University of Washington Institutional Review Board (UW IRB ID: STUDY00005363), with informed consent addressed in the email communication, and obtained from each participant as implied by survey completion.

2.2 THE mHEALTH APP

To address potential concerns with home application of FV, and provide a better patient experience, we designed two shell Android applications: one for the professional, and the other for the patient to assist in the correct site-specific application of the therapy. It allows providers and patients to communicate, to monitor adherence, and observe progress of the home-based treatment. Both applications are connected, and share a singular Firebase database. However, whereas the professional's application was adapted to be used on a tablet, the client's application was developed to be used on smartphones with an Android version of 5.0 and greater.

Figures 1(a-e) show steps within the general process of designing a customized patient file. At the initial visit to the dental office, the patient's mouth is examined, including areas of incipient decay, and recommended therapies are identified. The patient's information and prescribed treatments are then pushed to the database, so the patient can access this material after logging on via an Android mobile device. As they interact with the app, it records time stamps of activity and completed tasks. This information is pushed to the database, updating the latest date of therapy application and adding the patient's rating to their history. The provider can access the patient's information and evaluate patient progress, adherence, and answer any questions that may arise.

2.2a DENTIST APP INTERFACE

The tablet application opens up with the window that stores patient's name and birth date, and creates a 3D tooth model from cadnav.com (41). This model can be personalized by the provider to more accurately represent the client's teeth: delete missing teeth, or mark teeth as emerging or fully grown (Figure 1b). The software then allows the dentist to mark biting surfaces of the teeth (occlusal), or areas in between the teeth (interproximal) that need attention and an assigned therapy

application (Figure 1c). The application also allows the dentist to add details or any specific instruction in the text field. Check boxes are present in between teeth to indicate the interproximal sites. Figures 1(d) and 1(e) present a resulting model after complete editing. All the information is stored in the online database which can be accessed by the patients on their smartphone.

2.2b PATIENT APP INTERFACE

The Android application allows the patient to log in to the Firebase database using his/her credentials (Figure 2a). The app then loads the 3D teeth model that is representative of his/her teeth with marked targets (Figure 2b). The patients can zoom in, zoom out, rotate and open or close the mouth using the options on the side. Clicking on the target changes the 3D model to show only one target at a time with the detailed therapy description from the dentist's office. Clicking on the 'Done' button sends a notification to the database about the therapy application date (Figure 2c). The dentist can monitor whether the therapy application was late or on time for adherence monitoring, and the dialogue between patient and provider can continue beyond the office.

2.3 THE SURVEY

After consenting to participate, respondents completed an 11 question survey in REDCap (Appendix 2). Questions included baseline responses for routine use of FV, recall frequency for high-risk patients, history of providing AHFV, and history of using dental mHealth apps for patient benefit. Three main scenarios were posed regarding willingness to give AHFV for use by a parent for children: a) less than six years old, b) 6-12 years old, or c) more than 12 years old and in orthodontic treatment (braces). It was indicated that each child was identified as high caries-risk

due to having generalized incipient and/or white spot lesions. These are carious lesions that have not cavitated, and thus under the medical model would not necessarily require surgical intervention (9,10,12,14). It was also established that each scenario included a parent that the respondent would have deemed as *motivated*, so as to ensure an above-average level of trust from the provider for the capabilities and adherence potential of the parent. Provider demographics were also gathered, including year of pediatric residency completion (to represent age), gender, and primary and secondary places of practice. Additional space was made for free response comments.

2.4 DATA ANALYSIS

Counts and percentages were calculated for all variables within each intervention group (app vs. no app). Chi-square tests and slope analysis were used to determine any associations between the control and intervention groups and the willingness of the PD to prescribe AHFV for each of the three scenarios. Additionally, chi-square and Fisher's exact tests were repeated, stratifying group responses by previous use of FV or mHealth apps, gender, time practicing pediatric dentistry, and primary type of practice to determine if these variables were significant factors in willingness to give AHFV. The significance level was set to 0.05. Data analysis was performed using The R Project for Statistical Computing (42).

Chapter 3. RESULTS

3.1 BASELINE DATA and DEMOGRAPHICS

Of the 230 PDs contacted to participate, 116 met the inclusion criteria and fully completed the survey (50.4% response rate). Complete survey results for control and intervention groups are presented in Appedices 3 and 4, respectively. Table 1 provides a summary of the baseline question and demographic responses. The control group, or "no-app" group, had n=57 respondents, while the intervention, or "app" group, had n=59. The control and intervention groups showed no statistically significant distribution differences based on time in practice, gender, or primary place of practice. The overall median time since pediatric residency graduation, or time in practice, was 11 years. Thus each group was divided by a) practicing for ten or fewer years (newer graduates), or b) practicing for 11 or more years (experienced providers) for age-distribution analysis. Figures 3(a,b) show the no-app group had 45.6% (n=26) newer graduates, and the app arm had 49.2% (n=29) of participants in the newer range ($p = 0.76$). Gender was distributed at 54.5% (n=31) females, and 45.6% (n=26) males for the no-app group. The app group has 42.4% (n=25) females, 55.9% (n=33) males, and one respondent who marked "other, or decline to answer" (1.7%). Figures 4(a,b) show the gender distribution was not statistically unbalanced between the groups ($p = 0.27$). Type of practice showed nearly equal distribution of PD's in private practice for both groups: 80.7% (n=46) for no-app, and 81.4% (n=48) for the app group. The remaining percentages of PDs were similarly divided among academic, hospital, community clinic, or other pursuits, and these distributions were not significantly skewed between the two groups as seen in Figures 5(a,b) ($p = 0.76$).

For the baseline questions, consisting of questions #1, 2, 3, and 7, there were no statistically significant differences in response distribution between the two groups (Figure 6). A total of 98.3% (n=114) of PDs from both groups reported using FV on a regular basis (p = 0.24). Overall most PDs (86.2%) also stated that they do use a recall frequency of shorter than every six months for patients who have been deemed high caries risk (p = 0.32). Nearly equal numbers of PDs between both groups reported to have previously given FV for at-home use, with 21.1% (n=12) in the no-app group, and 23.7% (n=14) in the app group (p = 0.73). The same statement can be made for PDs who have previously recommended some type of mHealth app to their patients with 45.6% (n=26) in the no-app side compared to 40.7% (n=24) in the app arm.

3.2 TARGET SCENARIOS – AT-HOME FLUORIDE VARNISH

For the age-based scenarios in questions #4, 5, and 6 the distribution of providers willing to give FV for home use (a "yes" response) between control and intervention groups was not statistically significant for any scenario, nor significant overall (see Table 2 and Figure 7). However, a trend that willingness to give AHFV increases with the older child scenarios, and for the child in orthodontic treatment was noted. For a child less than six years old, a nearly equal number of PDs were willing to provide at-home FV, with 29.8% (n=17) in the control group, versus 30.5% (n=18) in the intervention side (p = 0.94). For a child between six to 12 years old both groups showed an increase in willingness to give FV, with 35.1% (n=20) in the no-app group, and a higher increase in the app group to 44.1% (n=26) (p = 0.32). For the last scenario of a child over 12 years old in braces, both groups again showed an increase in the AHFV option with 45.6% (n=26) in the no-app side, compared to the majority of PDs, or 57.6% (n=34) in the app group (p = 0.20).

3.3 SIGNIFICANT TRENDS ACROSS GROUPS

Stratification using baseline questions and demographics when a PD reported being willing to give AHFV for at least one scenario showed some significant relationships overall, but not in terms of the mHealth app presence. Table 3 presents data for these relationships across both groups. Providers with a previous history of giving AHFV in both groups were significantly more likely to give at-home FV than those that denied doing so before ($p < 0.001$). Overall, 67.8% of males were willing to prescribe the alternative FV protocol compared to 39.3% of females; this difference is significant ($p = 0.002$). Primary type of practice also showed a statistically significant effect on AHFV recommendation when comparing PDs spending some time in private practice compared to those spending no time in private practice, or all of their time in either academic, community-clinic, hospital, and/or other pursuits. Specifically 57.4% of private practicing PDs were willing to give AHFV in comparison to 26.7% of providers who spend 100% of their time in non-private practice ($p = 0.026$). Time in practice, and previous use of mHealth apps with patients did not show any impact on practitioners' decisions for AHFV.

Chapter 4. DISCUSSION

4.1 EFFECT OF THE mHEALTH APP

In terms of statistical analysis, no difference was noted based on p-values between the control and intervention groups' willingness to give at-home FV in any scenario. In one view this is encouraging that the surveyed PDs were not swayed significantly by the straight-forward app to modify their routine protocols. In general both groups had similar distributions of providers who follow the ADA's explicit guidelines for caries management, and those who choose to use professional judgment to customize therapies for specific patient scenarios as seen in Figure 7. The ADA is not a governing body, but represents a standard of care that can shift over time based on new findings in evidence-based dentistry. One respondent commented that AHFV is "frowned upon", but "if it [were] standardized, I would consider it". All respondent comments are listed in Appendix 5. The majority of respondents overall (86.2%) marked that they do generally adhere to guidelines for high-caries risk patients of a visit or recall frequency of less than six months (29).

Again, no statistical difference was found between groups for giving AHFV, yet it was apparent that there was a trend between increasing child age and increasing willingness to dispense FV, especially for the intervention group. Figure 7 shows the difference in slope between the control and intervention group responses with respect to increasing child age. The relationship of increasing child age and the PDs being more likely to dispense FV may be related to increased levels of trust for the parent or patient, or a decreased concern for toxicity event for the older children. Participant comments included: "trust of patients/parents prohibits us from allowing parents to apply at home", and concern for "accidental overdose". Lack of trust of patients completing therapies, such as brushing or flossing, routinely and effectively is a common finding among most dentists, and is not surprising in regards to the idea of a professionally-applied product

being sent home (43,44). Regarding FV toxicity, it was established earlier that the ADA recommends FV as the only professionally-applied topical fluoride treatment for children younger than six because of its reduced risk for a toxicity event compared to all other options; it has the lowest amount of fluoride per unit dose, especially compared to bottles of fluoride rinse or tubes of prescription toothpastes (21).

The increasing trend of at-home FV among the intervention group could be attributed to increasing patient age, but also due to the presence of braces in the oldest child. The high prevalence of incipient caries and white spot lesions among orthodontic patients was previously discussed, and intra-oral appliances represent a caries risk factor that is of concern to orthodontists and PDs (20,22,23). No respondent commented directly about the risk of WSLs for the child with braces, but these factors may have played a role in the increased willingness of the PDs to give FV by reason of the aim to prevent the development of WSLs. One respondent specifically mentioned giving FV for home use when children have "sensitive, badly decalcified permanent molars".

It is noteworthy that nearly 99% of PDs surveyed use FV on a regular basis, and furthermore over one-fifth of them have already given FV for at-home use. Other research has not shown such high rates of FV use among general or even pediatric dentists (26,27), and no study has reported rates of patient/parent applied AHFV. Again it can be viewed as a reassuring finding that the majority of PDs did not allow technology alone to push them to practice outside their usual standards, but perhaps the paradigm shift of the medical model had a hand in altering some of these PD's protocols. This shift may well be evident by the fact that a majority of dentists (average of 51.7%) were open to giving AHFV for the 12 year old child in braces with or without the app.

4.2 STRATIFICATION BY BASELINES & DEMOGRAPHICS

Despite the lack of association between the presence of the mHealth app and dispensing of AHFV, there was the trend with increasing patient age and patients with braces, and so the presence of other trends when stratified by the baseline questions and demographics were explored.

The first area of significance was found based on previous experience in giving AHFV. It would be reasonable to assume that PDs who had already given AHFV before would be more likely to do it again compared to their counterparts, and this hypothesis was statistically confirmed ($p < 0.001$). It was also found that of those that reported no history in giving AHFV that overall 42.2% were willing to provide the alternative therapy for at least one scenario (Table 3).

Next, in the current study males are much more likely to recommend AHFV than females overall ($p = 0.002$). The distribution of males and females across the groups was nearly equal, with the distribution between the groups assessed as not statistically significant ($p = 0.27$). Reasons for the disparity between genders and their willingness to provide an alternative therapy would require further investigation, and are specious based on limited literature. An extensive amount of research for provider gender disparities in patient perceptions, treatment, performance, and patient outcomes exists in the medical literature (45). Studies have found that when compared to their male counterparts, female physicians may be more likely to follow guideline-recommended protocols, and more patient-centered care (45,46). In this study it was found that women were more likely to follow the guideline-recommended protocol for FV by not opting for AHFV. Within the medical literature women physicians have been shown to give lower dosages of medication, and in this study male providers were more willing to give additional applications of the FV medicament for at-home use (47). It has also been reported that patients of female physicians may have better health outcomes, lower readmission rates, and lower mortality (48).

The dental literature is lacking in studies investigating similar provider gender disparities, especially regarding long-term patient health outcomes, due to the inherently reduced concern for mortality among dental patients, and the limited availability of large collections of dental patient data similar to what can be collected from large hospital populations in medicine. Further investigation into dental provider gender disparities regarding practice philosophies could shed more light on the variance discovered in this study.

Another significant difference was found based upon primary and secondary type of practice for the PDs. When grouped into PDs who work part or full-time in private practice compared to those that work 100% of their time in non-private settings (academic, hospital, community-clinic, other), it was shown that the private practitioners were more likely to give AHFV ($p = 0.026$). Again, dental literature is limited when considering differences in practice protocols between private and non-private dentists, leading to speculation in discussion. Points of discussion, warranting further investigation, may include that academic and hospital providers are more likely to have written, established guidelines and recommendations from their respective institutions and governing bodies. Such guidelines are generally developed with input from multiple academic sources, and agreed upon by many involved providers, compared to the protocols and decisions that a solo practitioner makes in his/her private office. However, the majority of dentists practice in a private setting, which is a valuable source of ideas, innovations, and the implementation of many new protocols that help push the profession to establishing new evidence-based standards. The standard of care is well defined as the "[The] degree of care and skill which is expected of a reasonably competent [dentist] acting in the same or similar circumstances." (49). Over time these standards change as evidence is established, and dental practice is influenced by paradigm shifts as discussed earlier.

The previous use of mHealth apps with their patients by PDs had no statistically significant bearing on giving AHFV between study groups, nor overall. The lack of bias related to previous mHealth app exposure shows that the decision to implement a new protocol was based on the PDs' established beliefs and practice strategies, and not upon a new informational tool. But as it was noted before, the PDs showed significant interest in using the alternative FV protocol anyways, again possibly due to the shift of beliefs and practice strategies towards medical model management. However, a well-designed app may be able to encourage providers to use new therapies and technology in a more statistically significant way than the trend noted in this study. One respondent who saw the app, and was willing to give AHFV for the two older child scenarios commented: "I like [that] the mobile app [gives] more concrete details … this could be a very useful tool for motivated parents".

Time in practice since completion of pediatric dental residency represented the relative age of the provider. In this study age was not a factor in the PD being influenced one way or the other by the presence of technology. The perspective and experiences of the general population have the bias that older generations have a more difficult time accepting, adapting to, and incorporating newer technologies, especially in the era of super computers and smartphones. Changes are reflected in reports that older adults are increasingly interested in accessing new technologies, but continue to have more difficult doing so compared to younger adults and children (50). These biases had no effect on this study's outcomes as older and younger providers alike commented positively about the app, and neither age group was swayed more than the other by the app.

4.3 FREE RESPONSE COMMENTARY

Comments were offered by 23 out of 116 respondents, and expressed many themes; some of which have been discussed in this section. All comments are included in Appendix 5. Themes

not addressed yet include a) focusing on diet management over additional fluoride use, b) motivated parents are more likely to return for more frequent visits and treatments, c) concern for cost and reimbursement of the procedure, and d) excitement for a customized, educational tool for parents at home.

Incorporation of the medical model of caries management within dentistry has caused more momentum in encouraging diet management practices that focus on decreasing frequency and exposure, in addition to the reduction in amount of fermentable carbohydrate intake (51). FV and other adjunct therapies represent an important part of the caries management experience, but a poor, cariogenic diet can undermine any efficacy of the standard brushing and flossing regimen. The American Academy of Pediatric Dentistry and International Caries Classification and Management System advocate for more frequent dental visits (every three months), FV application, and diet management strategies beyond the standard regimens for patients with increased caries risk (16,29).

AHFV does not have an ADA accepted billable CDT code for dentists, and thus PDs would not be able to charge for this service, and it would be at the dentist's expense. Recently the ADA added codes for teledentistry, including D9995 (synchronous, real-time encounter), and D9996 (asynchronous; information stored and forwarded to the dentist for subsequent review) (52). If these codes are reimbursed by third-party payors, and used by practitioners then it may pave the way for incorporation of other reimbursable at-home therapies. The positive comments from multiple respondents on how beneficial an mHealth app like ours might be for parents and patients is promising for further development and incorporation of effective and meaningful mHealth apps, especially those that carry the dental dialogue beyond the office. These efforts and perspectives are consistent with the current goals of teledentistry (30,31). A well-accepted

mHealth app similar to our design could continue to aid teledentistry to overcome barriers to care related to travels costs, office visits, disease management, and adherence monitoring, and the teledentistry codes could aid in reimbursement for at-home therapies like AHFV (31,32,33).

4.4 STRENGTHS & LIMITATIONS

Our study's control and intervention groups were well distributed among age, gender, and place of practice. The scenarios and questions were not reported to be unclear nor difficult to understand by respondents.

Though the app design was well received and commended, it may be beneficial to have an actual hands-on version that respondents could navigate and use. Additional respondents would have increased the statistical power, and some of the trends noted may have led to statistical significance with a larger study population. It would be of great value to future interested parties if inquiries are made about the primary area of practice for the PDs, specifically whether they practice in an urban, suburban, or rural area. Future studies that investigate similar questions as ours may also benefit from surveying PDs from other states, and even more so by including general dentists – especially those that worked in underserved populations, rural areas, or those that already use teledentistry.

Chapter 5. CONCLUSIONS

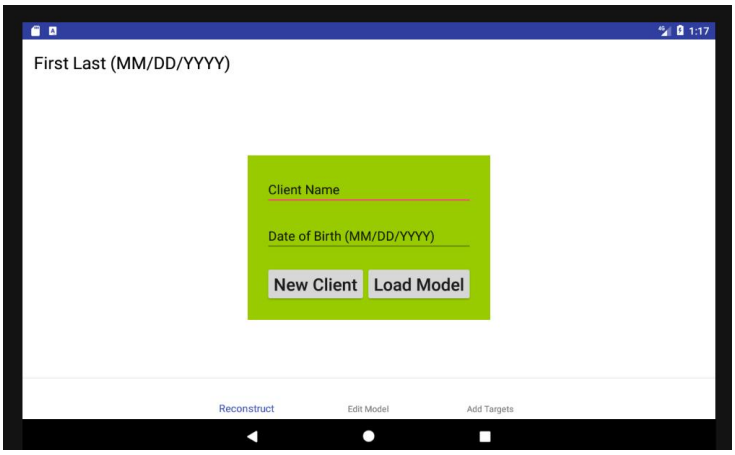
The results from this study suggest that the presence of technology, such as mHealth apps, have no statistically significant influence on PD providers to endorse a protocol outside of their regular routine to manage high-caries risk patients, specifically in recommending FV for at-home use. Despite the lack of statistical significance, a trend is noted that as the patient's age increased, or when the child was in orthodontic treatment, a provider was more willing to prescribe the alternative therapy when exposed to the mHealth app. Age of the provider, marked by time in practice, did not have a significant bearing on willingness to alter practice strategy based upon new technology. The limited effect due to age-of-provider is reassuring since younger generations are considered able to incorporate new tech more readily. Additionally, it was discovered that 22.4% of providers overall have already engaged in dispensing AHFV for patients to customize treatments based on specific patient needs and professional judgment, and are interested in pursuing new therapy modalities. Furthermore, though the mHealth technology in this study appears to not significantly sway PDs to practice beyond standard protocols, it is notable that among the scenarios between 29.8-57.6% of providers overall are already willing to recommend a customized, non-standard therapy beyond what is generally advised by governing bodies, such as the ADA. This suggests that providers may be open to seek newer medical model modalities, or to provide other normally in-office therapies for at-home use. It is interesting to note that male providers and PDs in private practice are more likely to give at-home FV compared to women, and providers in non-private setting, respectively. These findings may warrant further investigation and discussion. Ultimately, this study's outcomes are encouraging for the expansion of teledentistry efforts since many PDs are willing to provide alternative therapies, and many gave positive feedback about mHealth patient education efforts at home, which paves the way for more

interactive therapies for disease management. These observations are promising for the addition of new technologies and therapies, and for the continued development of the medical model within dentistry to customize treatment of the disease - not just the symptoms.

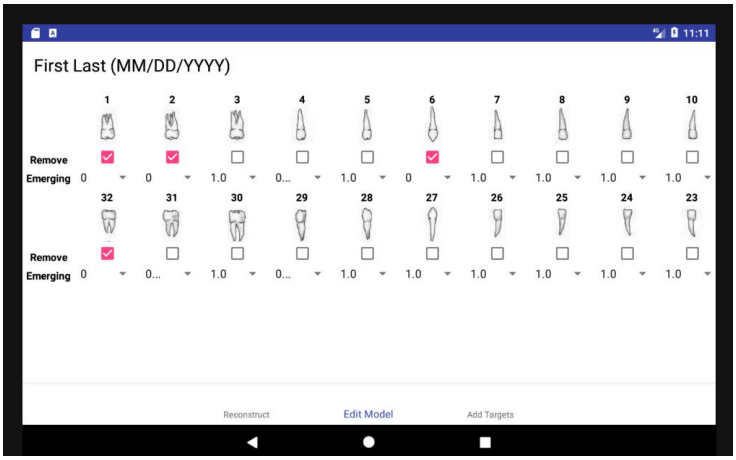
5.1 CONFLICT OF INTEREST

The authors have no conflicts of interest.

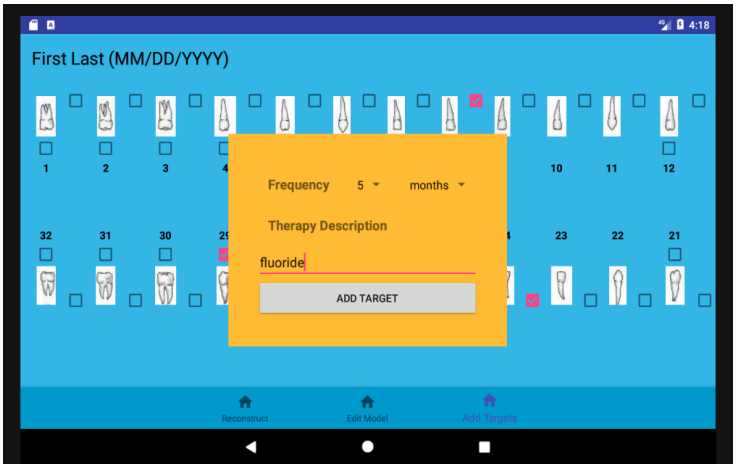
Figures 1 (a-e). App Screenshots – Dentist Portal and Interfaces



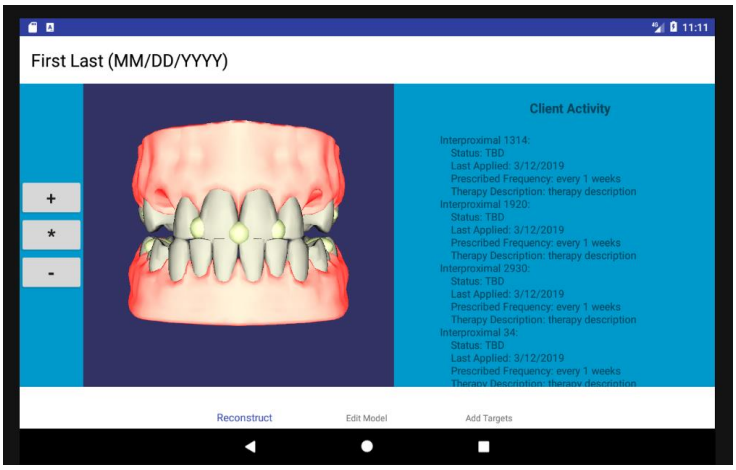
1(a) New patient entry portal



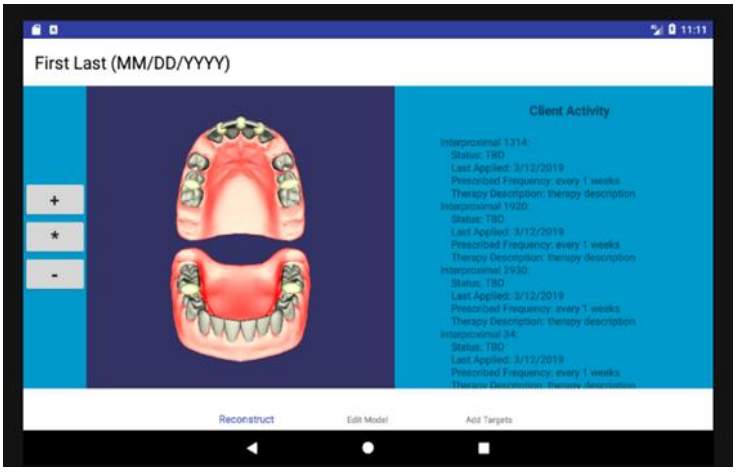
1(b) Tooth selection and emergence level screen



1(c) Therapy assignment and description screen

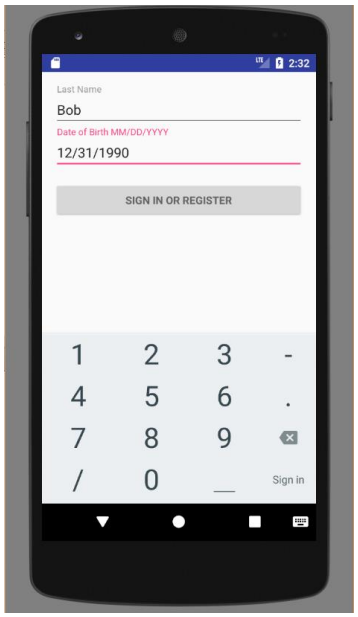


1(d) 3-D model with therapy site markers, closed view

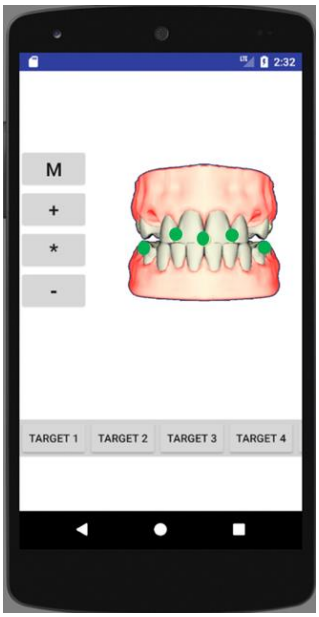


1(e) 3-D model with therapy site markers, open view

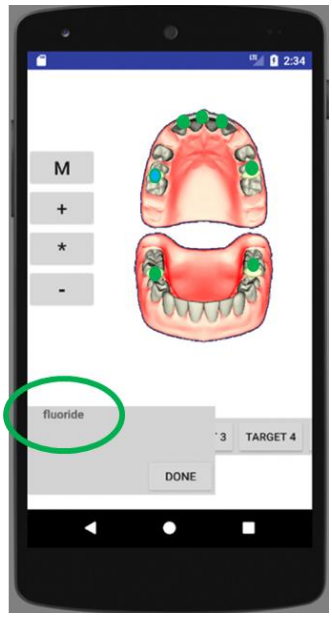
Figures 2 (a-c). App Screenshots – Patient Portal and Interfaces



2(a) New patient entry portal



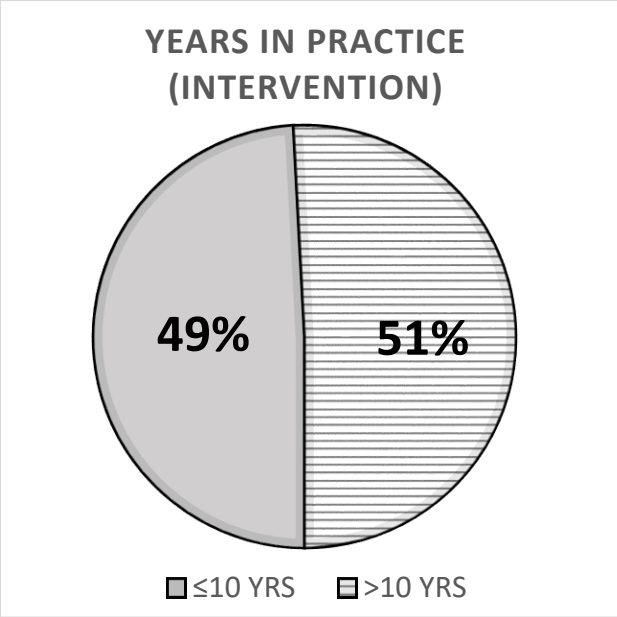
2(b) Therapy sites, closed view



2(c) Therapy sites with marked as “done”, open view

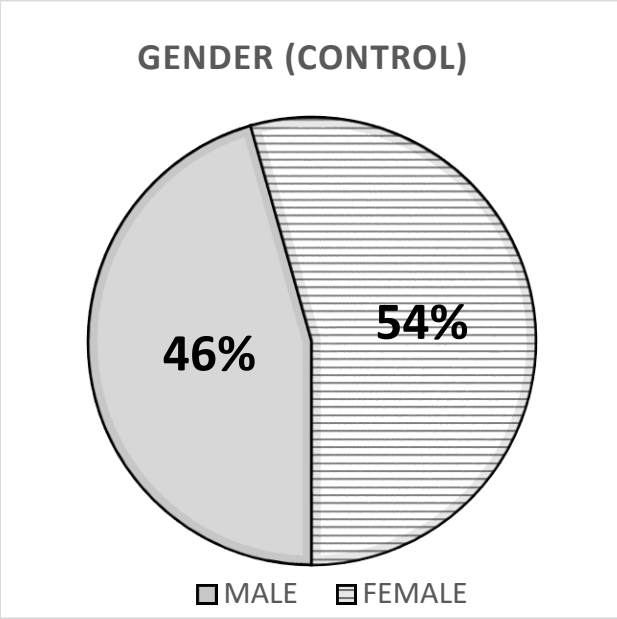
Figures 3(a-b). Years in Practice (time since completion of pediatric residency) (p = 0.76)

3(a) Distribution for control group by time in practice

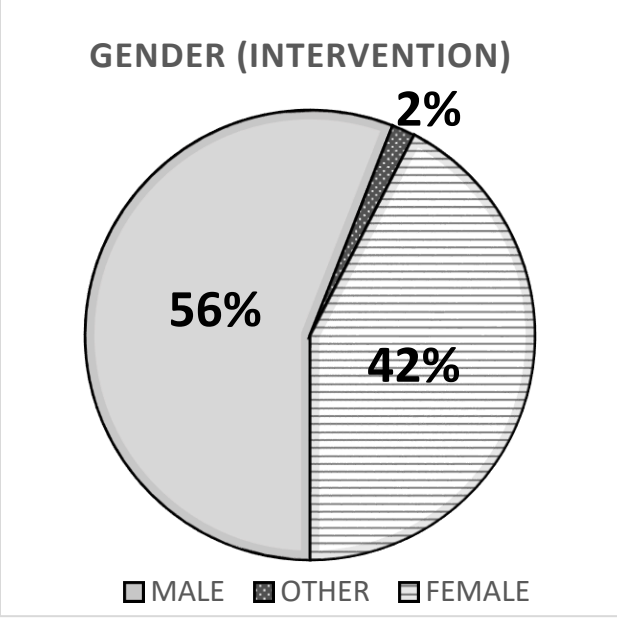


3(b) Distribution for intervention group by time in practice

Figures 4(a-b). Gender Distribution (p = 0.27)

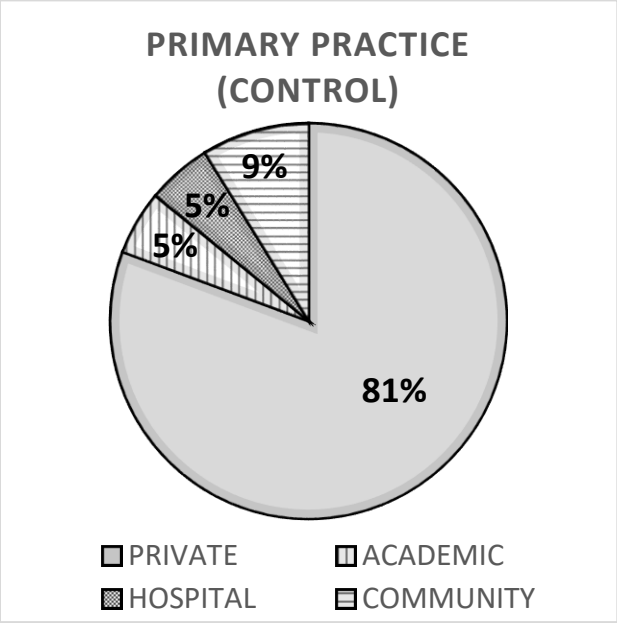


a) Distribution for control group by gender

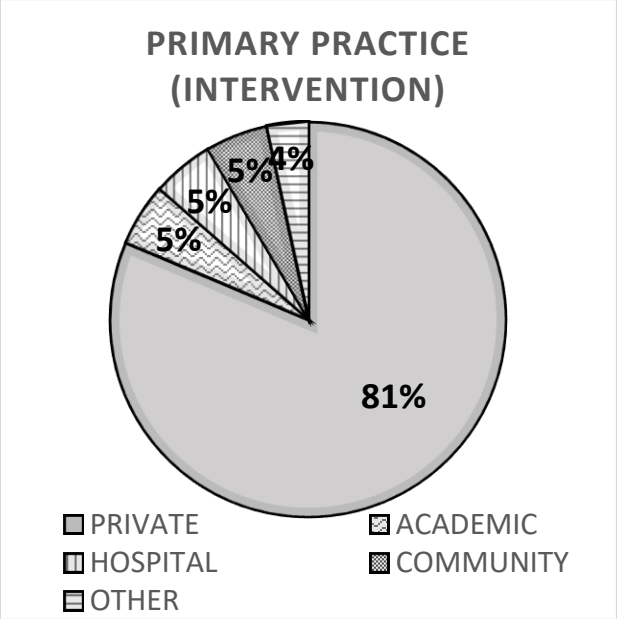


b) Distribution for intervention group by gender

Figures 5(a-b). Primary Type of Practice (p = 0.76)



a) Distribution for control group by primary type of practice



b) Distribution for intervention group by primary type of practice

Figure 6. Baseline Questions: FV use, recall frequency, & use of apps

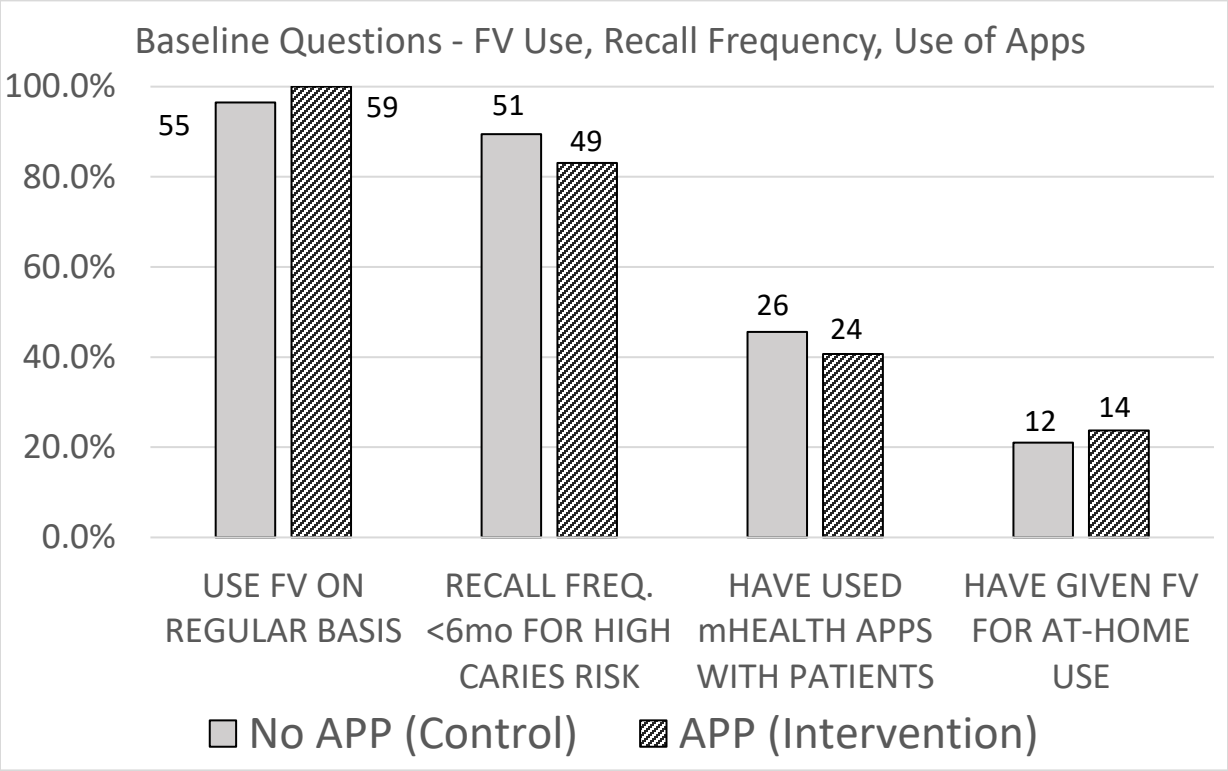


Figure 7. Scenario Questions: “Yes” response to AHFV

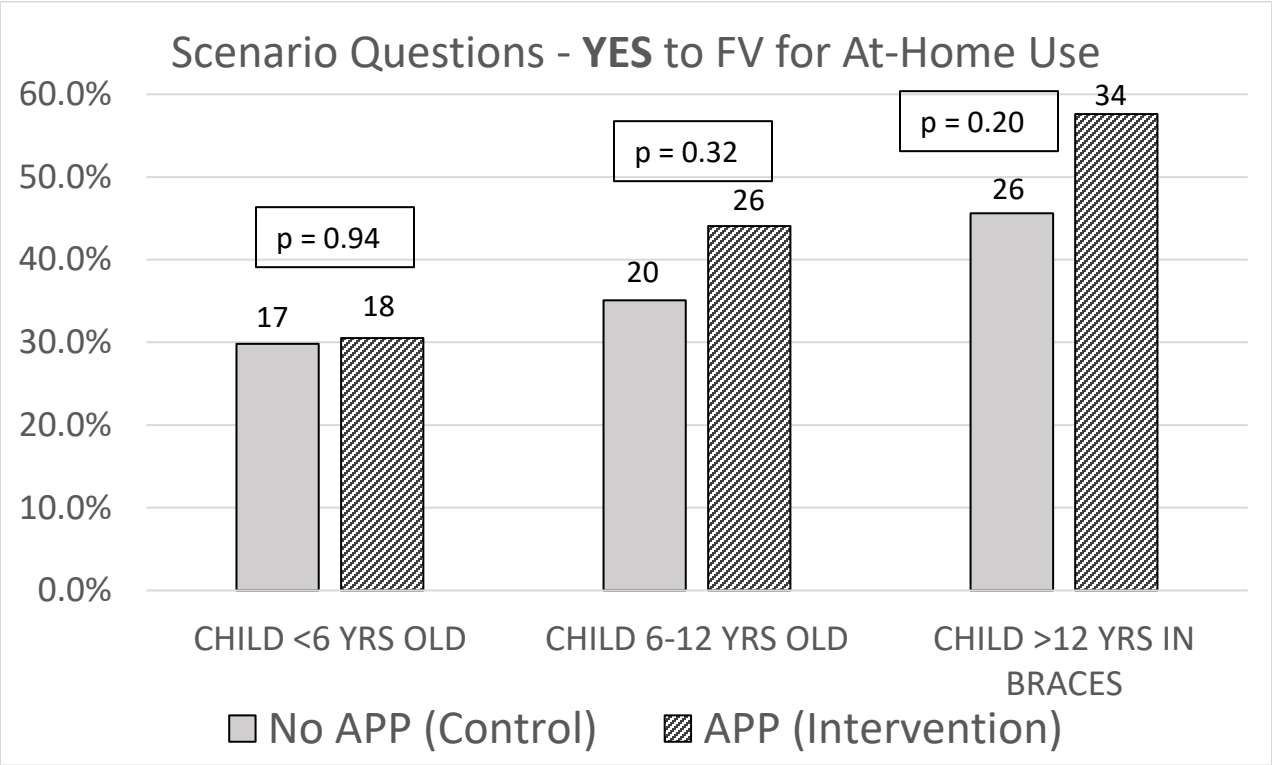


Table 1. Baseline and Demographic Data

TABLE 1: Baseline and Demographics				
	Total	Control	Intervention	p-value†
	N = 116	N = 57	N = 59	
	N (%)	N (%)	N (%)	
Q1) Uses 5% FV on regular basis				
No	2 (1.7%)	2 (3.5%)	0 (0.0%)	0.24‡
Yes	114 (98.3%)	55 (96.5%)	59 (100.0%)	
Q2) Does recall <6 mos for high-caries-risk				
No	16 (13.8%)	6 (10.5%)	10 (16.9%)	0.32
Yes	100 (86.2%)	51 (89.5%)	49 (83.1%)	
Q3) Has given 5% FV for home-use before				
No	90 (77.6%)	45 (78.9%)	45 (76.3%)	0.73
Yes	26 (22.4%)	12 (21.1%)	14 (23.7%)	
Q7) Has used/recommended mobile health applications before				
No	66 (56.9%)	31 (54.4%)	35 (59.3%)	0.59
Yes	50 (43.1%)	26 (45.6%)	24 (40.7%)	
Q8) Years in practice (time since pediatric residency)				
10 or fewer years	55 (47.4%)	26 (45.6%)	29 (49.2%)	0.76
11+ years	61 (52.6%)	31 (54.4%)	30 (50.8%)	
Q9) Gender				
Female	56 (48.3%)	31 (54.4%)	25 (42.4%)	0.27‡
Male	59 (50.9%)	26 (45.6%)	33 (55.9%)	
Other	1 (0.9%)	0 (0.0%)	1 (1.7%)	
Q10) Primary type of practice				
Academic	6 (5.2%)	3 (5.3%)	3 (5.1%)	0.76‡
Community Clinic	8 (6.9%)	5 (8.8%)	3 (5.1%)	
Hospital	6 (5.2%)	3 (5.3%)	3 (5.1%)	
Other	2 (1.7%)	0 (0.0%)	2 (3.4%)	
Private Practice	94 (81.0%)	46 (80.7%)	48 (81.4%)	
Q11) Secondary type of practice				
Academic	18 (15.5%)	10 (17.5%)	-13.60%	0.51‡
Community Clinic	9 (7.8%)	4 (7.0%)	5 (8.5%)	
N/A	80 (69.0%)	38 (66.7%)	42 (71.2%)	
Other	2 (1.7%)	0 (0.0%)	2 (3.4%)	
Private Practice	7 (6.0%)	5 (8.8%)	2 (3.4%)	
†Chi-square test unless otherwise indicated; ‡Fisher's Exact Test				

Table 2. Target Scenarios: Control (No App) vs. Intervention (App)

TABLE 2: Target Scenarios - No App vs. App				
	Total	Control	Intervention	p-value†
	N = 116	N = 57	N = 59	
	N (%)	N (%)	N (%)	
Q4) For child less than six years old				
No	81 (69.8%)	40 (70.2%)	41 (69.5%)	0.94
Yes	35 (30.2%)	17 (29.8%)	18 (30.5%)	
Q5) For child six to 12 years old				
No	70 (60.3%)	37 (64.9%)	33 (55.9%)	0.32
Yes	46 (39.7%)	20 (35.1%)	26 (44.1%)	
Q6) For child older than 12 years, with braces				
No	56 (48.3%)	31 (54.4%)	25 (42.4%)	0.20
Yes	60 (51.7%)	26 (45.6%)	34 (57.6%)	
Overall: Would give FV for at least one age group:				
No	54 (46.6%)	29 (50.9%)	25 (42.4%)	0.36
Yes	62 (53.4%)	28 (49.1%)	34 (57.6%)	
†Chi-square test unless otherwise indicated; ‡Fisher's Exact Test				

Table 3- Overall Associations from Stratified Results

TABLE 3: Associations - Stratified Results

Would give 5% FV for at-home use for *at least* one age group scenario

	Total	No	Yes	p-value†
	N = 116	N = 54	N = 62	
	N (%)	N (%)	N (%)	
Has given 5% FV for application at home before				
No	90 (77.6%)	52 (57.8%)	38 (42.2%)	<0.001
Yes	26 (22.4%)	2 (7.7%)	24 (92.3%)	
Has used/recommended mobile health applications before				
No	66 (56.9%)	32 (48.5%)	34 (51.5%)	0.63
Yes	50 (43.1%)	22 (44.0%)	28 (56.0%)	
Years in pediatric dental practice				
10 or fewer	55 (47.4%)	27 (49.1%)	28 (50.9%)	0.60
11+	61 (52.6%)	27 (44.3%)	34 (55.7%)	
Gender				
Female	56 (48.3%)	34 (60.7%)	22 (39.3%)	0.002‡
Male	59 (50.9%)	19 (32.2%)	40 (67.8%)	
Other	1 (0.9%)	1 (100.0%)	0 (0.0%)	
Private practice vs. "Non-private" (grouping of academic, community, hospital, other)				
100% Private	70 (60.3%)	29 (41.4%)	41 (58.6%)	0.17
Part/full-time Non-private	46 (39.7%)	25 (54.3%)	21 (45.7%)	
"Non-private" vs. Private practice				
100% Non-private	15 (12.9%)	11 (73.3%)	4 (26.7%)	0.026
Part/full-time Private	101 (87.1%)	43 (42.6%)	58 (57.4%)	

†Chi-square test unless otherwise indicated; ‡Fisher's Exact Test

Appendix 1. mHealth App Video Demonstration Voiceover Monologue

"Most patients who see their dentist for regular check-ups do so every 6 months. Guiding patients to develop the most effective and meaningful oral health and dietary habits can prove difficult for many providers in only two brief visits per year. To further educate patients about their own mouths, and to increase the efficacy of their personalized home regimens, we have developed a way for the dental dialogue to continue beyond the office using computer applications. This computer mobile health app allows the dentist to form a model representing a patient's oral condition, they can highlight areas of concern, and prescribe therapies or interventions. The patient is then able to access the app from home. The can monitor high risk areas, get instructions on proper hygiene techniques, and record adherence to prescribed regimens. Using the app the patient can begin to see their own mouth, or their child's mouth more from the dentist's perspective. The areas of concern the dentist is monitoring can become less abstract and more concrete. In this way the patient can become more involved in their own care, they can appropriately perform more focused therapies, and review their progress with their dentist at their next visit. The dentist is able to customize treatment therapies, guide home-care regimens more directly, and encourage their patients as they become more involved in their own oral health care."

Appendix 2. Survey Questions

1) Do you use 5% fluoride varnish for your patients on a regular basis in practice?
   a. Yes b. No
2) Do you recommend a recall frequency shorter than 6 months for patients you have identified as *high caries risk*? a. Yes b. No
3) Have you ever given or recommended 5% fluoride varnish to any patient/parent for application at home? a. Yes b. No
4) Would you give 5% FV for at-home use by a parent *you deem as motivated*, on their child with generalized incipient and/or white spot lesions that is *less than 6 years old*?
   a. Yes b. No
5) Would you give 5% FV for at-home use by a parent *you deem as motivated*, on their child with generalized incipient and/or white spot lesions that is aged *6-12 years old*?
   a. Yes b. No
6) Would you give 5% FV for at-home use by a parent *you deem as motivated*, on their child with generalized incipient and/or white spot lesions that is *12-18 years old and has <u>braces</u>*?
   a. Yes b. No
7) Have you ever used, or encourage patients to use any mobile health applications related to dentistry? a. Yes b. No

8) What year did you complete pediatric dental residency? _____
9) What is your gender? a. Female b. Male c. Other, or decline to answer
10) What is your primary area of practice (greater than 50% of your time)?
    a) Academic b) Private practice c) Community clinic d) Hospital e) Other
11) If you split your time in practice, what is your secondary (less than 50%) work situation?
    a) Academic b) Private practice c) Community clinic d) Hospital e) Other
    f) Not applicable

Appendix 3: Survey Results – Control Group

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
NO APP	Use FV	RC Freq <6	Hx Home FV	<6yo?	6-12yo?	Braces?	mHealth	Pedo	Gender	Primary	2ndary
1	Y	Y	N	N	N	N	N	2002	M	Private	Academic
2	Y	Y	N	N	N	N	Y	2016	F	Hospital	Academic
3	Y	Y	N	N	N	N	Y	2007	F	Academic	Private
4	Y	Y	N	N	N	Y	N	1994	F	Private	Academic
5	Y	Y	N	N	N	Y	Y	2016	M	Private	Academic
6	Y	Y	N	N	N	N	N	2006	M	Hospital	N/A
7	Y	Y	N	N	N	N	N	2011	F	Private	Academic
8	Y	Y	N	**Y**	**Y**	**Y**	N	2006	F	Private	Community
9	Y	Y	N	Y	Y	Y	Y	2009	M	Community	N/A
10	Y	Y	N	N	N	N	Y	2003	M	Community	N/A
11	Y	Y	N	N	Y	Y	N	2014	F	Community	Private
12	Y	Y	N	N	N	Y	Y	2014	F	Community	Private
13	Y	Y	N	N	N	N	N	2008	F	Private	N/A
14	Y	Y	N	N	N	N	Y	2018	F	Private	N/A
15	Y	Y	Y	N	N	N	N	2015	F	Private	N/A
16	Y	Y	N	N	N	N	Y	2015	F	Private	N/A
17	N	Y	N	N	N	N	N	2013	F	Private	N/A
18	Y	N	N	N	N	N	N	2012	M	Private	N/A
19	N	Y	N	Y	Y	Y	N	2018	M	Private	N/A
20	Y	N	N	N	Y	Y	N	1985	M	Private	N/A
21	Y	Y	Y	Y	Y	Y	Y	2009	M	Community	Academic
22	Y	Y	N	N	N	N	Y	1998	F	Private	Academic
23	Y	N	Y	Y	Y	Y	Y	2001	M	Private	N/A
24	Y	Y	N	Y	Y	Y	N	2008	F	Hospital	Private
25	Y	Y	N	N	N	N	Y	2014	M	Private	Community
26	Y	Y	N	N	N	N	N	2018	M	Academic	N/A
27	Y	Y	N	N	N	N	N	2016	F	Private	Academic
28	Y	Y	N	N	N	N	N	2004	M	Private	N/A
29	Y	Y	N	N	N	N	N	2011	F	Private	N/A
30	Y	Y	N	N	N	N	N	1998	F	Private	Academic
31	Y	N	N	N	N	N	Y	1996	F	Private	N/A
32	Y	Y	N	N	Y	Y	N	2018	M	Private	N/A
33	Y	Y	N	N	N	Y	N	1996	F	Private	N/A
34	Y	Y	Y	Y	Y	Y	N	2008	M	Private	N/A
35	Y	Y	Y	Y	Y	Y	Y	2007	M	Private	N/A
36	Y	N	Y	N	Y	N	Y	2008	F	Private	N/A
37	Y	Y	Y	Y	Y	Y	Y	1988	M	Private	N/A
38	Y	Y	N	Y	N	N	N	2007	F	Private	N/A
39	Y	Y	Y	N	N	N	Y	2009	F	Private	N/A
40	Y	N	Y	Y	Y	Y	Y	2011	F	Private	N/A
41	Y	Y	N	Y	Y	Y	Y	2008	M	Private	N/A
42	Y	Y	N	N	N	Y	Y	2007	F	Private	N/A
43	Y	Y	N	N	N	N	N	1997	F	Private	N/A
44	Y	Y	N	N	N	N	N	2005	F	Private	N/A
45	Y	Y	Y	Y	Y	Y	N	2010	M	Private	N/A
46	Y	Y	N	N	N	N	Y	2007	F	Private	N/A
47	Y	Y	N	N	N	N	N	1997	F	Private	N/A
48	Y	Y	N	N	N	N	Y	2009	F	Private	N/A
49	Y	Y	N	Y	Y	Y	N	1988	M	Private	Academic
50	Y	Y	N	N	N	N	N	1994	M	Private	N/A
51	Y	Y	N	N	N	Y	Y	2007	M	Private	N/A
52	Y	Y	N	N	N	Y	Y	2007	M	Private	N/A
53	Y	Y	N	Y	Y	Y	Y	2013	M	Private	N/A
54	Y	Y	N	N	N	N	N	2012	M	Private	Community
55	Y	Y	N	N	N	N	Y	2016	F	Academic	Private
56	Y	Y	Y	Y	Y	Y	N	2009	F	Private	Community
57	Y	Y	Y	Y	Y	Y	N	2006	M	Private	N/A
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
	Use FV	RC Freq <6	Hx Home FV	<6yo?	6-12yo?	Braces?	mHealth	Pedo	Gender	Primary	2ndary
	55	51	12	**17**	**20**	**26**	26	AVG	Male	Private	Private
	96.5%	89.5%	21.1%	**29.8%**	**35.1%**	**45.6%**	45.6%	2007	26	46	5
								MEDIAN	Female	Academic	Academic
								2008	31	3	10
								09/AFTER	Other	Hospital	Hospital
								26	0	3	0
						RESPONDENT		TOTAL	57	Community	Community
										5	4
								Before 09		Other	Other
								31		0	0
											N/A
											38

Appendix 4: Survey Results – Intervention Group

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
SAW APP	Use FV	RC Freq <6	Hx Home FV	<6yo?	6-12yo?	Braces?	mHealth	Pedo	Gender	Primary	2ndary
1	Y	N	N	Y	Y	Y	N	1972	M	Private	Academic
2	Y	Y	N	N	N	N	Y	2007	F	Private	Academic
3	Y	Y	N	N	N	Y	N	2000	F	Private	Academic
4	Y	Y	N	Y	Y	Y	N	1999	F	Private	N/A
5	Y	Y	N	N	N	N	Y	2010	M	Academic	N/A
6	Y	Y	N	N	N	N	N	2000	F	Academic	N/A
7	Y	Y	N	Y	Y	Y	Y	2016	M	Private	Academic
8	Y	Y	Y	Y	Y	Y	Y	1985	M	Academic	N/A
9	Y	Y	N	N	N	Y	Y	2015	M	Private	N/A
10	Y	Y	N	N	N	N	N	2010	F	Community	Academic
11	Y	N	N	N	N	N	Y	2004	M	Private	N/A
12	Y	N	Y	N	Y	Y	N	2017	F	Private	N/A
13	Y	Y	N	Y	Y	Y	N	2018	F	Hospital	Private
14	Y	Y	N	N	N	N	N	2008	M	Private	N/A
15	Y	N	N	N	Y	Y	N	1993	M	Private	N/A
16	Y	N	N	N	N	N	N	2009	M	Private	N/A
17	Y	N	N	N	N	N	N	2018	M	Private	N/A
18	Y	Y	N	N	N	N	Y	2012	F	Private	N/A
19	Y	Y	N	N	N	N	N	2018	M	Other	N/A
20	Y	Y	N	N	N	N	N	2007	M	Private	N/A
21	Y	Y	N	N	N	Y	Y	2007	M	Private	N/A
22	Y	Y	N	N	N	N	N	2001	F	Private	N/A
23	Y	Y	Y	N	N	Y	N	1987	M	Private	N/A
24	Y	Y	N	N	N	Y	N	2017	M	Private	N/A
25	Y	Y	N	N	N	N	Y	1979	M	Hospital	Other
26	Y	Y	N	N	Y	Y	N	2017	M	Private	N/A
27	Y	Y	N	N	N	N	Y	2018	F	Private	Community
28	Y	Y	N	N	N	N	N	1988	M	Private	N/A
29	Y	N	Y	Y	Y	Y	N	2011	M	Private	N/A
30	Y	Y	N	N	Y	Y	N	1987	M	Private	N/A
31	Y	Y	N	Y	Y	Y	Y	2015	M	Private	N/A
32	Y	Y	N	N	N	N	Y	2017	F	Private	Community
33	Y	Y	N	N	N	N	Y	2014	F	Private	N/A
34	Y	Y	N	N	N	Y	Y	1985	F	Hospital	N/A
35	Y	Y	N	N	Y	Y	Y	2014	F	Private	Academic
36	Y	Y	N	Y	Y	Y	Y	2016	F	Private	N/A
37	Y	Y	Y	Y	Y	Y	Y	2007	M	Private	N/A
38	Y	Y	Y	Y	Y	Y	N	2004	M	Private	N/A
39	Y	Y	Y	Y	Y	Y	Y	2016	M	Private	Academic
40	Y	N	N	N	N	N	N	2007	Other	Other	Community
41	Y	N	Y	Y	Y	Y	N	2010	M	Private	N/A
42	Y	Y	Y	N	Y	Y	Y	2008	F	Private	N/A
43	Y	Y	N	N	N	N	N	1988	M	Private	N/A
44	Y	Y	N	N	N	N	N	2001	F	Private	N/A
45	Y	Y	Y	Y	Y	Y	N	1996	M	Private	N/A
46	Y	Y	N	Y	Y	Y	N	1997	M	Private	N/A
47	Y	Y	Y	Y	Y	Y	Y	1988	M	Private	N/A
48	Y	Y	Y	N	Y	Y	N	1986	M	Private	N/A
49	Y	N	N	Y	Y	Y	N	2014	M	Private	N/A
50	Y	Y	N	Y	Y	Y	N	2014	F	Private	N/A
51	Y	Y	N	Y	Y	Y	N	2015	F	Private	Community
52	Y	Y	N	N	N	N	Y	2013	F	Private	Community
53	Y	Y	Y	N	Y	Y	Y	2007	M	Private	Academic
54	Y	Y	Y	N	N	Y	Y	2013	F	Private	N/A
55	Y	Y	N	N	N	Y	N	2009	M	Private	Other
56	Y	Y	N	N	N	N	Y	2001	F	Private	N/A
57	Y	Y	N	N	N	N	N	2001	F	Community	N/A
58	Y	Y	N	N	N	N	N	2009	F	Private	N/A
59	Y	Y	N	N	N	N	N	2009	F	Community	Private
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
	Use FV	RC Freq <6	Hx Home FV	<6yo?	6-12yo?	Braces?	mHealth	Pedo	Gender	Primary	2ndary
	59	49	14	**18**	**26**	**34**	24	AVG	Male	Private	Private
	100.0%	83.1%	23.7%	**30.5%**	**44.1%**	**57.6%**	40.7%	2005	33	48	2
								MEDIAN	Female	Academic	Academic
								2008	25	3	8
								09/AFTER	Other	Hospital	Hospital
								29	1	3	0
						RESPONDENT		TOTAL	59	Community	Community
										3	5
								Before 09		Other	Other
								30		2	2
											N/A
											42

Appendix 5: Survey Comments

Control Group:

1) "For at home use we often prescribe prevident to teenage patients or recc fl mouth rinse. Cost and trust of patients/parents prohibits us from allowing parents to apply at home."
    a. (2016, F, Private, Academic, for AHFV responded with all "No's")
2) "Would like to hear more background on the rationale for having parents do at home fluoride varnish treatments vs having them come in for more frequent visits. Obviously access to care/work/school attendance is an issue but generally we have parents and patients return for OH instructions/check as well as additional fluoride varnish applications to overall assess oral health, progress with change and motivate better OH/dietary practices. That is why I notated that I would not generally have a parent, even one that is motivated, to apply fluoride at home."
    a. (2011, F, Private, for AHFV responded with all "No's")
3) "Fluoride varnish seems an expensive "give-away" for unreimburseable home use. I don't believe it is available for prescribing. OTC fluoride rinses are great once children can spit... 3+. More focus on diet/hygiene at ALL ages as primary focus. Fluoride supplementation/use is secondary."
    a. (1996, F, Private, for AHFV responded with all "No's")
4) "I have a few situations where I gave FV for the parent to take home, but I rarely do this anymore."
    a. (2008, F, Private, for AHFV responded with "Yes" to ages 6-12, others "No")
5) "Commonly see children under 6 especially high risk or history of varied experience for 3 month recare interval with Fl varnish application"
    a. (2007, F, Private, for AHFV responded with "Yes" to under age 6, others "No")
6) "For my own high risk caries children , I use Mi paste and fluoride varnish at home as well as rinses, tabs, paste. They eat way too much sugar and I can't seem to stop it. I have given FV to a handful of parents but the ones who are really motivated fix their diet, and use fluoride rinse and tabs, with toothpaste. Often times , I give prescription toothpaste for kids in braces and if they aren't motivated self or by parents doing it, getting them to come in every three months is more effective. No matter how much fluoride local and systemic, if their diet isn't fixed, they will get caries."
    a. (2009, F, Private, for AHFV responded with all "No's")

Intervention Group:

1) "The app looks interesting! It seems like parents would really like the model of their child's mouth. I wonder how much the other components would be used."
    a. (2017, F, Private, for AHFV responded with "Yes" to 6-12, and 12+ braces)
2) "I am under the impression that giving parents fluoride varnish is frowned upon, due to the accidental overdose. However, if this was standardized, I would consider it, but would want to make sure to give clear instructions on safety. (Don't use the entire amount)."
    a. (2008, M, Private, for AHFV responded with all "No's")
3) "The questions asked if I would give parents a 5% FV to use at home. I wouldn't but I would consider other types of fluoride uses such as mouthwash or Rx fluoride TP."
    a. (2009, M, Private, for AHFV responded with all "No's")
4) "When applicable, I recommend that motivated parents of high risk patients return to my office for re-application of fluoride varnish."

a. (2018, M, Private, for AHFV responded with all “No’s”)

5) “Fluoride can easily be overdone-main reason for home application of varnish is for very sensitive badly decalcified permanent molars”
   a. (1987, M, Private, for AHFV responded with “Yes” to 12+ braces)
6) “I like the concept of the mobile app to give more concrete details on problem areas and prescribe treatment. I think this could be a very useful tool for motivated parents.”
   a. (2017, M, Private, for AHFV responded with “Yes” to 6-12, and 12+ braces)
7) “I prescribe President 5000 frequently in the situations you were asking about use of Fl varnish. While I think varnish is a good tool brushing in my opinion is key and I worry that patients may think the varnish will get them out of brushing. That is why I like prescription FL toothpaste.”
   a. (2018, F, Private, Community, for AHFV responded with all “No’s”)
8) “I think it's a fantastic app! Hope you develop, and market! And hope you continue to practice after becoming a millionaire!”
   a. (1987, M, Private, for AHFV responded with “Yes” to 6-12, and 12+ braces)
9) “ideal tool would use actual photo of patient's mouth when identifying high risk areas”
   a. (1985, F, Hospital, for AHFV responded with “Yes” to 12+ braces)
10) “I do this as an after visit summary for checkups. I have seen the dental software called "Sassy" that automatically generates a printout but I didn't want to learn how to use it since I'm used to traditional charting software. I think the most effective thing that parents report is the app that's connected to the electric toothbrush, and also using disclosing tablets at home.”
   a. (2014, F, Private, Academic, for AHFV responded with “Yes” to 6-12, and 12+ braces)
11) “Great app and development idea/area!”
   a. (2016, M, Private, Academic, for AHFV responded with “Yes” to all)
12) “I don't feel comfortable 5% FV application at home. People should emphasize on oral hygiene and dietary improvements, not focus on chemical therapy.”
   a. (1988, M, Private, for AHFV responded with all “No’s”)
13) “The mobile application is interesting, but unfortunately due to current reimbursements, I do not see it as a viable- ie. we don't get paid.”
   a. (2001, F, Private, for AHFV responded with all “No’s”)
14) “Many of my patients parents have loved the motivation that they got from the oral b magic timer app by Disney. Others have accessed the 2min2x videos or YouTube to help with their home care.”
   a. (2013, F, Private/community, for AHFV responded with all “No’s”)
15) “Cool App! Nice work.”
   a. (2009, M, Private, for AHFV responded with “Yes” to braces)
16) “Regarding at home use of prescription fluoride products for high risk patients, I prescribe Clinpro 5000 or MI Paste, typically for kids 5 and up. For younger kids, I will ask parents to use regular fluoride toothpaste and have the kids spit but not rinse at night, so that fluoride ions will remain in the mouth longer. We also recommend fluoride-embedded floss and fluoride rinses for moderate risk patients.”
   a. (2001, F, Private, for AHFV responded with all “No’s”)
17) “I do recommend below product for home use; 3M ESPE 12107B Just for Kids 0.4% Stannous Fluoride Brush On Gel”
   a. (2009, F, Private, for AHFV responded with all “No’s”)

Appendix 6. Statistical Analysis

Table 1: Summary of all data by intervention				
	Dental Health App Intervention			
	Entire Sample	Did not see app	Saw app	
	N = 116	N = 57	N = 59	
	N (%)	N (%)	N (%)	p-value†
Do you use 5% FV for your patients on a regular basis?				0.24‡
No	2 (1.7%)	2 (3.5%)	0 (0.0%)	
Yes	114 (98.3%)	55 (96.5%)	59 (100.0%)	
Do you recommend a recall < 6 months for high caries risk patients?				0.32
No	16 (13.8%)	6 (10.5%)	10 (16.9%)	
Yes	100 (86.2%)	51 (89.5%)	49 (83.1%)	
Have you ever given/recommended 5% FV for application at home?				0.73
No	90 (77.6%)	45 (78.9%)	45 (76.3%)	
Yes	26 (22.4%)	12 (21.1%)	14 (23.7%)	
Would you give 5% FV for at-home use by a parent you deem as motivated for child				0.94
No	81 (69.8%)	40 (70.2%)	41 (69.5%)	
Yes	35 (30.2%)	17 (29.8%)	18 (30.5%)	
Would you give 5% FV for at-home use by a parent you deem as motivated for child				0.32
No	70 (60.3%)	37 (64.9%)	33 (55.9%)	
Yes	46 (39.7%)	20 (35.1%)	26 (44.1%)	
Would you give 5% FV for at-home use by a parent you deem as motivated for child				0.20
No	56 (48.3%)	31 (54.4%)	25 (42.4%)	
Yes	60 (51.7%)	26 (45.6%)	34 (57.6%)	
Have you ever used, or encourage patients to use any mobile health applications				0.59
No	66 (56.9%)	31 (54.4%)	35 (59.3%)	
Yes	50 (43.1%)	26 (45.6%)	24 (40.7%)	
Number of Years Since Completed Pedo Residency				0.76
10 or fewer years	55 (47.4%)	26 (45.6%)	29 (49.2%)	
11-20 years	37 (31.9%)	20 (35.1%)	17 (28.8%)	
21+ years	24 (20.7%)	11 (19.3%)	13 (22.0%)	
Gender				0.27‡
Female	56 (48.3%)	31 (54.4%)	25 (42.4%)	
Male	59 (50.9%)	26 (45.6%)	33 (55.9%)	
Other	1 (0.9%)	0 (0.0%)	1 (1.7%)	
Primary Area of Practice				0.76‡
Academic	6 (5.2%)	3 (5.3%)	3 (5.1%)	
Community	8 (6.9%)	5 (8.8%)	3 (5.1%)	
Hospital	6 (5.2%)	3 (5.3%)	3 (5.1%)	
Other	2 (1.7%)	0 (0.0%)	2 (3.4%)	
Private	94 (81.0%)	46 (80.7%)	48 (81.4%)	
Secondary Area of Practice				0.51‡
Academic	18 (15.5%)	10 (17.5%)	8 (13.6%)	
Community	9 (7.8%)	4 (7.0%)	5 (8.5%)	
N/A	80 (69.0%)	38 (66.7%)	42 (71.2%)	
Other	2 (1.7%)	0 (0.0%)	2 (3.4%)	
Private	7 (6.0%)	5 (8.8%)	2 (3.4%)	
Would give 5% FV for at home use for at least one age group				0.36
No	54 (46.6%)	29 (50.9%)	25 (42.4%)	
Yes	62 (53.4%)	28 (49.1%)	34 (57.6%)	
†Chi-square test unless otherwise indicated; ‡Fisher's Exact Test				

Associations with %FV				
	Would give 5% FV for at home use for at least one age group			
	Entire Sample	No	Yes	
	N = 116	N = 54	N = 62	
	N (%)	N (%)	N (%)	p-value†
Dental Health App Intervention				0.359
Did not see app	57 (49.1%)	29 (50.9%)	28 (49.1%)	
Saw app	59 (50.9%)	25 (42.4%)	34 (57.6%)	
Do you use 5% FV for your patients on a regular basis?				0.99‡
No	2 (1.7%)	1 (50.0%)	1 (50.0%)	
Yes	114 (98.3%)	53 (46.5%)	61 (53.5%)	
Do you recommend a recall < 6 months for high caries risk patients?				0.434
No	16 (13.8%)	6 (37.5%)	10 (62.5%)	
Yes	100 (86.2%)	48 (48.0%)	52 (52.0%)	
Have you ever given/recommended 5% FV for application at home?				<0.001
No	90 (77.6%)	52 (57.8%)	38 (42.2%)	
Yes	26 (22.4%)	2 (7.7%)	24 (92.3%)	
Have you ever used, or encourage patients to use any mobile health applications				0.632
No	66 (56.9%)	32 (48.5%)	34 (51.5%)	
Yes	50 (43.1%)	22 (44.0%)	28 (56.0%)	
Number of Years Since Completed Pedo Residency				0.607
10 or fewer years	55 (47.4%)	27 (49.1%)	28 (50.9%)	
11-20 years	37 (31.9%)	18 (48.6%)	19 (51.4%)	
21+ years	24 (20.7%)	9 (37.5%)	15 (62.5%)	
Number of Years Since Completed Pedo Residency				0.603
10 or fewer years	55 (47.4%)	27 (49.1%)	28 (50.9%)	
11+ years	61 (52.6%)	27 (44.3%)	34 (55.7%)	
Gender				0.002‡
Female	56 (48.3%)	34 (60.7%)	22 (39.3%)	
Male	59 (50.9%)	19 (32.2%)	40 (67.8%)	
Other	1 (0.9%)	1 (100.0%)	0 (0.0%)	
Primary Area of Practice				0.19‡
Academic	6 (5.2%)	5 (83.3%)	1 (16.7%)	
Community	8 (6.9%)	4 (50.0%)	4 (50.0%)	
Hospital	6 (5.2%)	3 (50.0%)	3 (50.0%)	
Other	2 (1.7%)	2 (100.0%)	0 (0.0%)	
Private	94 (81.0%)	40 (42.6%)	54 (57.4%)	
Secondary Area of Practice				0.83‡
Academic	18 (15.5%)	8 (44.4%)	10 (55.6%)	
Community	9 (7.8%)	6 (66.7%)	3 (33.3%)	
N/A	80 (69.0%)	36 (45.0%)	44 (55.0%)	
Other	2 (1.7%)	1 (50.0%)	1 (50.0%)	
Private	7 (6.0%)	3 (42.9%)	4 (57.1%)	
Private Practice				0.172
Some "Other" Practice Type	46 (39.7%)	25 (54.3%)	21 (45.7%)	
100% Private Practice	70 (60.3%)	29 (41.4%)	41 (58.6%)	
"Other" Practice Type				0.026
Some Private	101 (87.1%)	43 (42.6%)	58 (57.4%)	
100% "Other" Practice Type	15 (12.9%)	11 (73.3%)	4 (26.7%)	
†Chi-square test unless otherwise indicated; ‡Fisher's Exact Test				

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