THE FIVE-YEAR EFFECTIVENESS OF THE TEXAS FIRST DENTAL HOME PROGRAM

A Thesis

by

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Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

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August 2014

Major Subject: Oral Biology

ABSTRACT

This study examined the Texas Medicaid First Dental Home (FDH) program in rural and urban private pediatric dental practice settings and evaluated its five-year impact on caries severity, age of onset of decay, and treatment location. Comparisons were made between FDH participants and traditional Medicaid recall participants who were seen prior to the inception of the FDH program.

Statistical analysis of the total subject pool (N=492) demonstrated that the average age of the first dental visit differed significantly between recall and FDH groups, at 18.2 months and 13.4 months, respectively ($p<0.0001$). For those subjects with caries, both the average age and the average decayed, missing, filled teeth (dmft) score at the first decay episode differed significantly. The FDH children were 3 months younger ($p=0.05$) when decay was first identified, and their average dmft was 1 point higher ($p=0.02$). The location for providing treatment did not differ significantly between groups ($p=0.3$). The rural group on average visited the dentist for the first time 1.5 months later than the urban group ($p=0.008$), and the first decay episode on average occurred 6 months later in the rural subjects compared to the urban subjects ($p=<0.0001$).

Data were stratified based on the age of occurrence of the first decay episode, and significant results were found for the 0-36 month age group (N=68). In this age group, no significant difference was found between rural and urban practice settings. There was a significant difference between dmft scores for the recall and FDH groups

(6.0 for recall and 3.7 for FDH, p=0.007). The location of treatment also differed significantly between the recall and FDH groups, with 15 subjects (65%) of the recall group and 15 subjects (33%) of the FDH group requiring treatment in the operating room rather than in-office (p=0.012).

These results suggest that for those Medicaid patients who did experience decay episodes before the age of 36 months, the FDH program is reducing the severity of decay as judged by dmft. Additionally, the FDH program resulted in a reduction in the use of the operating room for treatment of those decay episodes.

DEDICATION

I would like to dedicate this thesis to my family in recognition of their boundless love and support throughout my journey so far. I thank God every day for my husband and best friend, Andrew, my parents, Gary and LuAnne Halbert, and my husband's parents, Randy and Carol McFarland. I am grateful as well for the encouragement of my younger brother, Travis, my grandparents, Joy, Tex, Martha, and L.P., and my cousins, Natalie, Emily, John, Dustin, Meagan, Crystal, Amber, Ashley, and Stephen Paul – you are not only my family, but my friends. Finally, I might not have made it through the bad days without my sweet dogs to greet me every day when I arrived home. Ginny and Dougal, I miss you every day, and Scout, Blue, and Rowan, you bring me so much joy. You'll always be my fuzzy children. I love you all.

ACKNOWLEDGEMENTS

I am so grateful for the time and effort that the Texas A&M Baylor pediatric dentistry faculty have invested in me over the past two years. Special thanks are owed to Drs. Carolyn Kerins, Kavitha Viswanathan, Alton McWhorter, and Jason Koesters for their assistance with this project. Dr. Ceib Phillips and Jingxiang "Sean" Chen of the University Of North Carolina Chapel Hill School Of Dentistry also helped immensely with the statistical analysis for this project, for which I am very thankful.

I also owe many thanks to Drs. Sarita Shah, Ed Swift, Jeni Criss, Bill Steinhauer, Sharon Hill, and Martha Ann Keels for their guidance and mentorship both personally and professionally. Lastly, I would be remiss if I didn't thank Leslie Yuan for her wisdom and encouragement over the past five years, and Tory Holderby for convincing me that getting my Master's degree was worth the time and effort. I am so lucky to have godly women like you to offer me wisdom and advice.

God is good, and I am truly blessed.

NOMENCLATURE

AAPD	American Academy of Pediatric Dentistry
ADA	American Dental Association
dmft	Decayed, Missing, Filled, Teeth index
ECC	Early Childhood Caries
EPDV	Early Preventive Dental Visits
FDH	First Dental Home
HIPAA	Health Insurance Portability and Accountability Act
IRB	Institutional Review Board
NPE	New Patient Exam
OR	Operating Room
S-ECC	Severe Early Childhood Caries

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

FIGURE Page

CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

The prevalence of dental caries across the general population is on the decline, but one segment of the population, preschool-aged children 2-5 years old, saw a rise in dental caries between 1988 and 2004.[1] The caries process was found to be most active in the poor and near poor U.S. preschool-aged populations; but across all socioeconomic groups, if the children were identified as having caries, several teeth were often affected. Of the decayed tooth surfaces identified, 72% of them were untreated.[1, 2] Decay in early childhood is a serious problem, and unfortunately it seems to be largely unaddressed in this segment of the population.

In 2000, the U.S. Surgeon General reported that dental caries is the most common chronic disease of childhood, and is five times more common than asthma[3] and is the most prevalent unmet health care need of poor U.S. children of all ages, with preschool-aged children being especially vulnerable."[4] The 2009 update on early childhood caries (ECC) stated that ECC is still one of the most serious and costly health conditions among young children.[2] In that same year, Cassamassimo emphasized the importance of addressing the ECC problem, stating that ECC and its treatment can lead to serious disability and even death.[5]

The problem of ECC is not new to dentists. It has historically been referred to as "baby bottle tooth decay" or "nursing caries." The American Academy of Pediatric

Dentistry (AAPD) defines early childhood caries as the presence of 1 or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child 71 months of age or younger. Severe early childhood caries (S-ECC) occurs in children less than 3 years of age or may be further defined as 1 or more cavitated, missing (due to caries), or filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing, or filled score of $\geq$4 (age 3), $\geq$ 5 (age 4), or $\geq$6 (age 5).[6] Anecdotally, many pediatric dentists claim the S-ECC pattern of decay is occurring in high-risk patients earlier than ever before, sometimes at less than one year of age.[2]

Children exhibiting S-ECC have been shown to be at greater risk for developing additional carious lesions in both the primary and permanent dentitions.[7-9] The consequences of ECC and S-ECC, though, are not only the child being at higher risk for developing future carious lesions, but also an increased likelihood of being diagnosed as failure to thrive,[10] increased treatment costs,[11] missed school days,[12] and diminished quality of life.[5, 13, 14] This is a heavy price to pay for a preventable disease.

A significant percentage of children experiencing ECC and S-ECC require dental restorative treatment under general anesthesia in the operating room (OR) due to extent of treatment needs and young age. Treatment in the OR is financially costly with facility fees and anesthesiologist fees costing more than dentistry related fees. Recently anesthesia researchers have uncovered possible prolonged deleterious effects of multiple general anesthesia exposures. These early, frequent exposures to general anesthetics may have lasting negative effects on the future behavioral development of the young brain, such as attention-deficit hyperactivity disorder.[15-18]

How do dentists prevent decay from occurring in children at this young pre-cooperative age? If decay should occur in early childhood, what is the best tactic to keep the decay from becoming so extensive and severe? History has given the dental profession some tentative answers, and there is new research published every day that sheds more light on the matter.

One of the principal causative agents of dental caries is the bacterium *Streptococcus mutans*. Early colonization of the oral cavity with *S. mutans* is considered a caries risk indicator,[19-23] and colonization with *S. mutans* can be used to identify children at high risk for developing caries.[20, 24, 25] It has been reported that caregivers with salivary *S. mutans* themselves also have children colonized with *S. mutans*,[23, 26, 27] but transmission can occur horizontally (from other caregivers, siblings, friends) in addition to vertically (from parent to child), with some studies suggesting that mothers are not even the main source of salivary *S. mutans* in their children.[28, 29] Still, working to reduce the primary caregivers' and infants' pathogenic *S. mutans* counts, by the use of xylitol sources for example, has been shown to reduce the incidence of caries in those children.[26, 30] *S. mutans* reduction, therefore, has become a target of many caries preventive measures in the dental profession. It is important to remember, though, that the plaque biofilm that leads to decay contains many organisms and not just *S. mutans*. The development of plaque is a highly individualized process,[31] and preventive measures should be individualized as well as some preventive tactics are not suitable for children under age 3.

Additional caries-risk indicators are previous decay episodes,[32, 33] enamel hypoplasia,[23, 34] a diet high in fermentable carbohydrates,[22, 24, 35, 36] particularly if the carbohydrates come in a liquid form that is taken to bed as a bottle or sippy cup,[37] visible plaque on the teeth,[23, 36, 38, 39] and socioeconomic status.[40, 41] All of these factors have been linked to an increased prevalence of dental caries, and many of them have also been associated with an increased likelihood of *S. mutans* colonization.[42] Each of these factors, either alone or in combination, has been a target of early preventive programs attempting to reduce ECC in children.

Equally important to note, there are protective factors against dental caries. These include: parent-assisted brushing,[37, 43] starting brushing before age two,[37] use of fluoridated toothpaste while brushing,[43, 44] saliva,[22, 45] and antibacterial therapy.[22] These factors, like the caries-risk factors, are modifiable by the parents. Both types of factors can be improved if the parent is educated by the dental professional and decides to change his or her current behavior patterns. The goal is to find a balance between the pathological and preventive factors.[22]

Education has become an integral part of most dental caries preventive plans. A Swedish study from 1975 provided dietary and oral hygiene counseling to mothers, and resulted in a 65% reduction in decay in their children when compared to the controls.[46] Another Swedish study found that the prevalence of caries in the children of mothers who received oral health-related counseling was decreased by 42% after four years.[47] In 2001, Rozier looked at three systematic reviews and concluded that although counseling programs directed at mothers may increase their oral health knowledge, the causal

relationship between knowledge and behavior change is not strong or based on sufficient evidence.[48]

Several additional studies have been published since 2001. The technique of motivational interviewing is a counseling method that promotes and engages intrinsic motivations. The technique was examined in a 2004 study, and demonstrated a 63% reduction of new decay in the children of mothers who experienced motivational interviewing.[49] A 2008 study provided oral health education to women during their pregnancy and also at age six and twelve months of their infants. The intervention resulted in a significantly decreased incidence of S-ECC at age two in those children of mothers who had received the education.[50] In this study children of these mothers who were educated beginning in pregnancy were followed further, and at ages 6-7 years those children had less severe caries and less toothaches than the children in the control group.[51] It seems, then, that more evidence is mounting in support of the education and counseling component of caries prevention. The effect of the early education of mothers may be so strong as to have a sustainable impact upon caries reduction in offspring for many years.[51]

There is even evidence that suggests that the education can be provided by non-dental professionals and still be effective. A 2010 study reported on educational workshops put on by members of the healthcare community who were non-dental professionals. The purpose of the workshops was to educate new mothers. The study found that the mothers' knowledge was increased and their self-reported behaviors changed as a result of what they learned.[52] The key element, then, is that the mothers

were educated about their own oral health and their child's oral health, and the particular type of delivery system may not be as important.

Still, not all recent evidence is in favor of educational programs. One psycho-social study examined mothers' oral health knowledge and beliefs and found that although the mothers were knowledgeable about appropriate feeding practices and oral hygiene practices after the educational intervention, nearly 75% of mothers still had fatalistic attitudes in regards to their child's oral health, as they believed that most children would develop tooth decay.[53] Another study in 2010 concluded that although parental oral health knowledge may improve as a result of an education program, that does not necessarily correlate with improved oral health practices.[54] Neither study looked at caries incidence in the children; they only looked at self-reported behavioral changes of the mothers. It may be possible that a caries reduction effect was achievable despite the perceived lack of change in behaviors. Ultimately, it remains somewhat unclear as to how strong of a role caregiver education plays in the prevention of caries in their children, but current best practice recommendations still focus on and encourage educating caregivers and providing anticipatory guidance under the belief that it will aid in caries prevention.[55]

Another factor related to decreasing the severity of dental caries once the patient has decay is the likelihood of children with decay receiving timely treatment. The biggest variable is insurance coverage. It has been demonstrated that preschool-aged children who are not covered by any type of insurance, medical or dental, experience more decay than their insured peers. Additionally, those with only medical insurance

experience more decay than their peers who are covered by both medical and dental insurance.[56]

Divaris,[57] in 2014 examined a cohort of young Medicaid-enrolled children and noted when they entered into the dental care system and what factors influenced that entry. The study found that only 39% of the children entered the dental care system, and of those, 13% were first seen on an emergent basis. It was also noted that children who had oral health problems reported at baseline were more likely to enter the dental care system. Thus, the severity of disease may be driving the entrance of patients into the dental care system. But, the availability of dental insurance coverage may not be the entire story. Even when this group of children had access to free dental insurance through Medicaid, the entry into dental services was still poor. Not unexpectedly, the reasons behind the existence of such a large proportion of untreated dental decay in the preschool aged population are multifactorial.

Despite having dental insurance that covers routine preventive care, many parents of Medicaid patients use the hospital emergency room as their primary dental care source for their children.[58] A rise in non-traumatic preventable dental emergency room visits was reported in 2006, as well as an increase in dental caries-related hospital admissions.[59] This may be an access to care issue, as some states have poor Medicaid reimbursement rates and as a consequence have small numbers of participating dental Medicaid providers. It could also be due to other health disparities experienced by minority groups within the population, such as less physician engagement,[60] the need for translation services, or lack of reliable transportation, or be related to differing cultural

beliefs regarding dental health care.[61] Whatever the cause, the cost of dental services provided in the emergency room is significantly greater than in private practice, and such services are problem-based in nature and cannot address the comprehensive oral health care needs of the children. This rising trend toward emergency room dental care increases the economic burden of dentistry on the health care system at large and prolongs the suffering of children with significant dental health care needs by addressing only emergent dental issues.

The emergency room isn't the only place with rising costs related to dental care for this preschool-aged population. Numerous healthy young children are also taken to the OR every year to receive restorative treatment for S-ECC and ECC provided under general anesthesia. Such care is significantly more costly than when performed in private practice.[11] This increased cost may be one of the primary reasons many states are adopting early preventive dental programs in an effort to reduce the disease burden on this young high-risk population and in return, curb excessive health care costs related to dentistry. The goals of these preventive programs are many: 1. prevent decay altogether 2. reduce the severity of caries experience 3. delay onset of decay until child is older and cognitively capable of cooperating for treatment in the dental office.

A number of national organizations promote the establishment of a dental home by one year of age.[62-65] The concept of a dental home mimics that of a medical home. The dental home is an ongoing relationship between the family and dentist inclusive of all aspects of oral health, providing comprehensive, coordinated, and continuously accessible care. Therefore, with a dental home, the patient would have access to

preventive services and would, in theory, be able to avoid the need for urgent care in the emergency room. It is recommended that the dental home be established by 12 months of age.[62] There is emerging evidence that such early preventive visits may be cost effective and reduce both future disease and dental costs.[66]

In many states, though, the problem is not necessarily convincing parents to bring their child to the dentist by his or her first birthday, but rather finding a dentist in their community who is willing and able to treat these very young children. There has historically been a lack of training and willingness among general dental providers to provide dental services to the preschool aged group of children.[67-70] This lack of available providers may be part of the reason why families feel that the only place for them to turn for dental treatment is the emergency room, and why their child's decay goes untreated until the only way to manage it is in the OR under general anesthesia.

In response to a legal settlement, *Frew v. Suehs*, several initiatives were passed to increase access to dental care for Texas Medicaid patients. One of those initiatives was the establishment of the First Dental Home (FDH) program. The FDH program encourages both pediatric dentists and certified general dentists to provide care to this patient population by offering competitive fees and a large patient pool.[71]

As of October 2013, there were 2,601,879 children enrolled in Medicaid in the state of Texas, with 776,014 of them being under the age of five.[72] Although there are 300 active pediatric dentists in Texas, it is still physically impossible for all Medicaid enrolled children in the state of Texas to be seen by a pediatric dentist. This does not even take into account children that are either private pay or have private insurance. The

role of general dentists in the care of children, therefore, is a crucial one, particularly for this high-risk Medicaid population.

With its implementation in 2008, the FDH program's primary objective was to increase the number of available providers of routine dental care to high-risk children under the age of three in the form of pediatric dentists and certified general dentists. The program was also meant to prevent those children from developing early childhood caries and to avoid more expensive treatment costs associated with dental restorative care provided in the hospital OR under general anesthesia.[71, 73]

The Texas FDH program encourages parents to bring their child to the dentist at six months of age and then to return for subsequent routine visits every three months until the child reaches 36 months of age. At each visit the parent receives age-appropriate anticipatory guidance and education regarding his or her child's oral health, and the child receives a dental examination, a toothbrush prophylaxis, and a fluoride varnish application. A caries risk assessment is also performed, and recommendations are catered to the individual needs of the child and his or her family.[55, 73-76]

Two of the most important aspects of the FDH program are education and fluoride varnish application. The potential benefits of caregiver education have been discussed previously, and it was concluded that caregiver education does appear to play at least some role in the prevention of dental caries. Fluoride varnish has also been shown to be an effective caries preventative agent for moderate and high-risk populations when applied at least every six months.[48, 77-83] Fluoride varnish is the safest mode of fluoride delivery for this young population because it adheres to the teeth and

less of it is swallowed. This decreases the risk of fluorosis, although it is important to note that fluorosis, though considered unaesthetic by some parents, has actually been shown in its mild form to make teeth more caries resistant.[84, 85] Fluoride has the ability to remineralize carious lesions by shifting the ion exchange balance between the enamel and saliva toward the influx of calcium, phosphate, and fluoride ions.[86-88] Fluoride varnish also has greater patient acceptability in preschool aged children when compared to fluoride gel.[89] The American Dental Association (ADA) and AAPD recommend fluoride varnish applications every three months for high-risk individuals, which is why such an intervention is an integral part of the caries preventive efforts of the FDH program.[83]

There have been several studies in the past decade examining early prevention programs similar to the FDH program that included both education and a fluoride application. One such study showed increased utilization of dental services,[90] and four other studies demonstrated a decrease in caries incidence as judged by decayed, missing, or filled surfaces (dmfs) or teeth (dmft).[43, 91-93] A recent comprehensive review examined the literature related to Early Preventive Dental Visits (EPDV) and concluded that the evidence to support the effectiveness of EPDVs and the age 1 dental visit is rather weak. The reviewers do, however, state that EPDVs at least appear to be beneficial for children before age 3 if they are part of the high-risk group for decay or if they have existing dental disease.[94]

Further research is needed to determine the true impact of the various proposed EPDV programs that exist, but for now present professional knowledge and

organizational recommendations continue to encourage early preventive visits like those that are a part of the Texas FDH program, especially for children at high risk for dental caries. The purpose of this study was to evaluate the effectiveness of Texas' FDH program at reducing the severity of decay and the costs of dental treatment for its high-risk Medicaid population. Additionally, this study examined differences in effectiveness of the FDH program based on practice location (rural versus urban). With the country on the verge of sweeping changes in health care, it is imperative to evaluate the effectiveness of existing programs so that they can be bolstered, modified, or terminated.

CHAPTER II

SUMMARY AND CONCLUSIONS. THE FIVE-YEAR EFFECTIVENESS OF THE TEXAS FIRST DENTAL HOME PROGRAM

INTRODUCTION

Although the prevalence of dental caries across the general population is on the decline, the preschool-aged population aged 2-5 years saw a rise in dental caries between 1988 and 2004.[1] In 2000 the U.S. Surgeon General reported that dental caries is the most common chronic disease of childhood, and is five times more common than asthma.[3] The 2009 update on early childhood caries (ECC) stated that ECC is still one of the most serious and costly health conditions among young children.[2]

The problem of ECC is not a new one to dentists. It has historically been referred to as "baby bottle tooth decay" or "nursing caries." Early childhood caries involves the early inoculation of the child with cariogenic bacteria that when combined with a high carbohydrate diet can cause formation of dental caries as early as months of age or shortly after the eruption of the first tooth. Today, the American Academy of Pediatric Dentistry (AAPD) defines ECC as the presence of 1 or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child 71 months of age or younger. Many pediatric dentists state

anecdotally that severe ECC (S-ECC) is occurring in high-risk patients earlier than ever before, sometimes at less than one year of age.[2]

Children exhibiting S-ECC have been shown to be at greater risk for developing additional carious lesions in both the primary and permanent dentitions.[7-9] The consequences of ECC and S-ECC, though, are not only the child being at higher risk for developing future carious lesions, but also diminished quality of life due to pain or disturbances in activities, school, eating, or sleep.[13, 14] Untreated decay may lead to failure to thrive[10] and as infection spreads it may become life threatening and lead to increased treatment costs.[11]

Due to the extent of dental caries, coupled with the patient's young age and inability to cooperate, many patients require restorative dental treatment under general anesthesia in the operating room (OR). This early exposure to general anesthesia is not only monetarily costly,[15] but anesthesiology researchers have uncovered possible prolonged deleterious effects of multiple general anesthesia exposures. These early, frequent exposures to general anesthetics may have a lasting negative effect on the future behavioral development of the young brain, such as attention deficit hyperactivity disorder.[16-18]

The First Dental Home (FDH) program was established by the state of Texas Health and Human Services in 2008. The FDH initiative began in response to a class action legal settlement, *Frew v. Suehs*.[71] The goals of the FDH program were to increase access to dental care and to reduce the incidence of ECC via early, frequent dental visits, parental education, and the use of fluorides. It was postulated that reduction in caries or

delayed onset would correlate to decreased treatment costs. In order to prevent decay and reduce the severity if decay occurs, the balance between decay promoting factors and protective factors must be shifted. See Table 1.[19-25, 32-45] This may be accomplished through parental education.

Education has become an integral part of most dental caries preventive plans, although some studies have demonstrated that increased oral health knowledge did not correlate with parental behavior changes.[48] Motivational interviewing has shown effectiveness through a 63% reduction of new decay in children of mothers who experienced motivational interviewing.[49] Providing oral health education to women during their pregnancy, and again at age six and twelve months of their infants' age, resulted in a significantly decreased incidence of S-ECC at age 2.[50] The effect of this pre-natal and early education is substantive, as children of these parents had less severe caries and less toothaches at ages 6-7 years.[51] Therefore evidence is mounting in support of the education and counseling component of caries prevention. Ultimately, it remains somewhat unclear as to how strong of a role caregiver education plays in the prevention of caries in their children, but current best practice recommendations still focus on and encourage educating caregivers and providing anticipatory guidance, under the belief that it still plays a role in caries prevention.[55]

The concept of a dental home mimics that of a medical home. The dental home is an ongoing relationship between the family and dentist inclusive of all aspects of oral health, providing comprehensive, coordinated, and continuously accessible care. The

dental home provides both preventive and emergent care. It is recommended that the dental home be established by 12 months of age.[62]

In many states the problem is not necessarily convincing parents to bring their child to the dentist by his or her first birthday, but rather finding a dentist in their community who is willing and able to treat these very young children. There has historically been a lack of training and willingness among general dental providers to provide dental services to the preschool-aged group of children.[67-70] This lack of available providers may be part of the reason why families feel that the only place for them to turn for dental treatment is the emergency room, and why their child's decay goes untreated until the only way to manage it is via full mouth dental rehabilitation in the OR under general anesthesia.

The Texas FDH program encourages both pediatric dentists and certified general dentists to provide care to this patient population by offering competitive fees and a large patient pool.[71] As of October 2013, there were 2,601,879 children enrolled in Medicaid in the state of Texas, with 776,014 of them being under the age of five.[72] Although there are 300 active pediatric dentists in Texas, it is still physically impossible for all Medicaid enrolled children in the state of Texas to be seen by a pediatric dentist. This does not even take into account children that are either private pay or have private insurance. The role of general dentists in the care of children, therefore, is a crucial one, particularly for this high-risk Medicaid population.

The Texas FDH program encourages parents to bring their child to the dentist at six months of age and then to return for subsequent routine visits every 3 months until

the child reaches 36 months of age. At each visit the parent receives age-appropriate anticipatory guidance and education regarding his or her child's oral health, and the child receives a dental examination, a toothbrush prophylaxis, and a fluoride varnish application. A caries risk assessment is also performed, and recommendations are catered to the individual needs of the child and his or her family.[55, 73-76]

There have been several studies in the past decade examining early prevention programs similar to the FDH program, i.e. they included an educational component and a fluoride component. These studies showed increased utilization of dental services,[90] and a decrease in caries incidence as judged by decayed, missing, or filled surfaces (dmfs) or teeth (dmft).[43, 91-93] Reviews of related programs such as Early Preventive Dental Visits (EPDV) found that the effectiveness of EPDVs and the age 1 dental visit is rather weak, although they do seem beneficial for children before age 3 if they are part of the high-risk group for decay or if they have existing dental disease.[94] Further research is needed to determine the true impact of the FDH and other EPDV programs that exist, but for now present professional knowledge and organizational recommendations continue to encourage early preventive visits, especially for children at high risk for dental caries.

The purpose of this study was to evaluate the effectiveness of Texas' FDH program at reducing the severity of decay and the costs of dental treatment for its high-risk Medicaid population. Additionally, this study examined the differences in effectiveness of the FDH program based on practice location (rural versus urban). With the country on the verge of sweeping changes in health care, it is imperative to evaluate

the effectiveness of existing programs so that they can be bolstered, modified, or terminated.

MATERIALS AND METHODS

Approval for this retrospective chart review was obtained by the Institutional Review Board (IRB) at The Texas A&M University Baylor College of Dentistry in Dallas, Texas. Three private pediatric dental offices were selected for the study, one urban and two rural. A computer-generated report using the office's software (Dentrix®, Eaglesoft®) identified patients for the recall and First Dental Home (FDH) groups utilizing the dental billing codes D0120 and D0145. Patients were included if the FDH group their first visit occurred between January 1, 2008 and April 1, 2013. Recall patients were selected if their first visit occurred between January 1, 2003 and December 31, 2007. A database was created and subjects were selected for inclusion using a random number generator. All pertinent IRB protocols for the Health Insurance Portability and Accountability Act (HIPAA) were followed.

Inclusion criteria were: Medicaid patients who experienced at least 2 caries-free visits at the dental office before age 36 months. Qualifying visits were either an NPE and a recall visit or two FDH visits. Exclusion criteria were: private pay or non-Medicaid insurance, lacking at least two caries free visits in the office before 36 months of age, or previous dental treatment, or experiencing both traditional NPE and recall

visits as well as FDH visits. The latter exclusion criterion would have occurred during the transition period with the establishment of the FDH program.

The age of the first decay episode and a dmft score were determined for each study subject. For the age of the first decay episode, the patient's chart was examined and the child's age in months was calculated based on his or her birthday and the date on which decay was first diagnosed. The dmft score was calculated by tallying the number of teeth with decay. Permanent teeth were included in the dmft index, when present. The "missing" or "filled" portion of the dmft index was not applicable in this study since the children were excluded if they presented with existing decay or existing treatment. The dmft was not cumulative (i.e., at subsequent episodes, a new dmft was recorded that only listed newly decayed teeth and did not count the previously restored or extracted teeth, unless recurrent decay was present).

Treatment location was determined by examining the treatment codes (e.g. D9420 for hospital versus D9230 for nitrous oxide and D9248 for oral conscious sedation) and clinical notes from the day that treatment was rendered. If multiple treatment locations existed, only the final location required to complete all treatment was recorded. Treatment location was categorized as either in-office or in the OR. Types of in-office treatment included: watching with fluoride varnish application (D1206), intermittent therapeutic restoration (D2941), nitrous oxide (D9230), and oral conscious sedation (D9248).

Additional data collected included: gender, total number of NPE and recall visits or FDH and recall (if followed beyond age 3) visits, practice type (rural versus urban),

age at first dental visit, age at last dental visit, age(s) at caries episode(s), dmft at caries episode(s), and treatment location for caries episode(s).

Over 3000 charts were reviewed. The data were stratified for analysis based on the age at which the first decay episode occurred. For statistical analysis, the Pearson $\chi 2$ statistic was used to assess whether the two groups differed with respect to nominal variables, and the Mann Whitney U test was used to assess whether the two groups differed in distribution of responses for ordinal and continuous variables. IBM SPSS statistical software version 21 was utilized for the analysis.[95]

RESULTS

The total study population contained 492 subjects, 199 of which were traditional Medicaid recall patients and 293 of which were FDH patients. The sample contained 259 males and 233 females, and 256 rural and 236 urban subjects. A total of 171 subjects experienced decay (35%), with 72 (36%) from the recall group and 99 (34%) from the FDH group. There were 127 subjects (64%) in the recall group and 194 subjects (66%) in the FDH group that did not experience any decay episodes during their observation period in the dental office.

The average age of the subjects' first visit to the dental office was 18.2 months for the recall group and 13.4 months for the FDH group. The average age of the final recorded visit to the dental office was 49.5 months for the recall group and 45.2 months for the FDH group. The average period of time observed by the dental office for each

group was 31.3 months for the recall group and 31.8 months for the FDH group. The average age of the first decay episode was 44.8 months for the recall group and 41.1 months for the FDH group. The average length of time between the first dental visit and the first decay episode was 26.9 months for the recall group and 26.5 months for the FDH group. The average dmft score was 4.3 for the recall group and 5.1 for the FDH group. Finally, of the subjects with decay, 55 recall subjects (28%) were treated in the office compared to 84 FDH subjects (29%), and 17 recall subjects (9%) were treated in the OR compared to 15 FDH subjects (5%) (Table 2).

Statistical analysis of all 492 study subjects demonstrated that gender, practice type, the average age of the last dental visit, the average length of time between the first dental visit and the first decay episode, and the average total period of observation did not differ significantly between the recall and FDH groups (Table 3). The average age of the first dental visit did differ significantly between recall and FDH groups, at 18.2 months and 13.4 months, respectively ($p<0.0001$). For those subjects with caries, the average age of the first decay episode and the average dmft at the first episode also differed significantly. The FDH children were younger (41.1 months versus 44.8 months, $p=0.05$) when decay was first identified, and the average dmft was larger (5.1 versus 4.3, $p=0.02$). The location of treatment for caries did not differ significantly between groups, with 17 subjects (9%) of the recall group and 15 subjects (5%) of the FDH group requiring treatment in the OR rather than in-office (Figure 1).

The study population was also analyzed based on rural or urban practice setting. Of the 171 subjects that experienced decay, 83 (49%) came from the rural group and 88

(51%) came from the urban group. There were 173 subjects (68%) in the rural group and 148 subjects (63%) in the urban group that did not experience any decay episodes during their observation period in the dental office.

The average age of the subjects' first visit to the dental office was 16.1 months for the rural group and 14.5 months for the urban group. The average age of the final recorded visit to the dental office was 55.6 months for the rural group and 54.5 months for the urban group. The average period of time observed by the dental office for each group was 33.3 months for the rural group and 29.8 months for the urban group. The average age of the first decay episode was 46.0 months for the rural group and 39.4 months for the urban group. The average length of time between the first dental visit and the first decay episode was 31.5 months for the rural group and 26.8 months for the urban group. The average dmft score was 3.8 for the rural group and 5.7 for the urban group. Finally, of the subjects with decay, 70 rural subjects (84%) were treated in the office compared to 69 urban subjects (78%), and 13 rural subjects (16%) were treated in the OR compared to 19 urban subjects (22%) (Table 4).

Statistical analysis of all 492 subjects demonstrated that gender, visit type, the average age of the last dental visit, the average length of time between the first dental visit and the first decay episode, the average total period of observation, and average dmft score did not differ significantly between the rural and urban groups (Table 5). The average age of the first dental visit did differ significantly between rural and urban groups, at 16.1 months and 14.5 months, respectively ($p=0.008$). For those subjects with caries, the average age of the first decay episode also differed significantly. The urban

children were younger (39.4 months versus 46.0 months, $p<0.0001$) when decay was first identified. The dmft scores did not differ significantly between groups, with 3.8 for the rural group and 5.7 for the urban group. The location of treatment for caries also did not differ significantly between groups, with 13 subjects (16%) of the rural group and 19 subjects (22%) of the urban group requiring treatment in the OR rather than in-office.

The data were stratified for further analysis based on the age at which the first decay episode occurred. The age ranges analyzed were: 0-36, 36-42, 42-48, 48-54, 54-60, 60-66, and 66-72 months. Only subjects whose decay occurred before 36 months of age resulted in findings that were statistically significant. That sample contained 68 subjects; 23 were traditional Medicaid recall patients and 45 were FDH patients. The sample contained 38 males and 30 females, and 18 rural and 50 urban subjects. All included subjects experienced a decay episode.

The average age of the subjects' first visit to the dental office was 14.7 months for the recall group and 14.5 months for the FDH group. The average age of the final recorded visit to the dental office was 62.9 months for the recall group and 55.4 months for the FDH group. The average period of time that the patient was observed by the dental office was 37.7 months for the recall group and 38.2 months for the FDH group. The average age of the first decay episode was 30.0 months for the recall group and 31.1 months for the FDH group. The average length of time between the first dental visit and the first decay episode was 15.3 months for the recall group and 16.7 months for the FDH group. The average dmft score was 6.0 for the recall group and was 3.7 for the FDH group. Finally, 8 recall subjects (35%) were treated in-office compared to 30 FDH

subjects (67%), and 15 recall subjects (65%) were treated in the OR compared to 15 FDH subjects (33%) (Table 6).

In comparing the recall and FDH groups, gender, practice type, the average age of the first and last visits, the average age of the first decay episode, the average length of time between the first dental visit and the first decay episode, and the average total period of observation did not differ significantly between groups (Table 7). The average dmft at the first decay episode differed significantly between the two groups, with 6.0 for the recall group and 3.7 for the FDH group ($p=0.007$). The location of treatment for the decay also differed significantly between groups, with 15 subjects (65%) of the recall group and 15 subjects (33%) of the FDH group requiring treatment in the OR rather than in-office ($p=0.012$) (Figure 2).

The final analysis of the subjects with decay episodes that occurred before 36 months compared rural and urban practice settings. The average age of the subjects' first visit to the dental office was 14.5 months for both groups. The average age of the final recorded visit to the dental office was 53.2 months for the rural group and 59.6 months for the urban group. The average period of time that the patient was observed by the dental office was 33.8 months for the rural group and 39.7 months for the urban group. The average age of the first decay episode was 31.3 months for the rural group and 30.5 months for the urban group. The average length of time between the first dental visit and the first decay episode was 16.7 months for the rural group and 16.0 months for the urban group. The average dmft score was 5.5 for the rural group and 4.1 for the urban group. Finally, 10 rural subjects (56%) were treated in-office compared to

28 urban subjects (56%), and 8 rural subjects (44%) were treated in the OR compared to 22 urban subjects (44%) (Table 8). None of the above listed parameters were significantly different between the rural and urban groups (Table 9).

DISCUSSION

Based on the statistical analysis of this study, it appears that the FDH program has resulted in positive change since its inception. This study's total sample of almost five hundred subjects demonstrated that the FDH patients are first seen by the dentist nearly five months earlier than they were previously seen as traditional Medicaid recall patients. This allows for potentially cariogenic dietary and/or oral hygiene practices to be addressed earlier in the child's life. Theoretically, this could lead to a reduction in caries prevalence, rate of progression, and severity. The study was unable to conclude whether it was parental education versus fluoride application or a cumulative effect of both that led to the reduction in caries in the FDH group.

In addition to a difference in the average age of the first dental visit between recall and FDH groups, the data also demonstrate that the age of the first decay episode occurred about three months later in the recall group than in the FDH group. This may be due to the increased amount of time between recall visits (every 6 months for recall subjects versus every 3 months for FDH subjects). It may be that the decay was present just as early in the recall group, but simply wasn't identified and documented until later due to the greater length of time between routine visits.

It was also found when examining the total study population that the average dmft was about one point higher for the FDH group than the recall group. This may be due to the fact that a cutoff for the maximum age of the first decay episode was not utilized. The recall group contained a greater number of subjects who were followed to older ages compared to the FDH group, simply due to the collection time periods. This extended observation period allowed time for recall patients who were caries free at younger ages to experience their first decay episode at older ages, and these were likely smaller than the high dmfts often seen at younger ages. These decay episodes were averaged equally into the recall group's dmft score, which may have skewed the results because these later, smaller decay episodes simply haven't had the chance to occur in the FDH group because the patients were still too young on average as a group.

Related to practice setting, it was found that urban patients visited the dentist earlier than their rural counterparts. Additionally, it was found that the first decay episode occurred significantly later for rural patients compared to urban patients. These findings may point to access to care issues. There are fewer pediatric dentists in rural areas, and often no general dentists willing to see children under the age of 3, which makes it difficult for many parents to bring their children to the dentist by the recommended age of 12 months. This difficulty in accessing early preventive care may have delayed the timeliness of decay diagnosis. It could be that the decay in the rural group was recorded nearly six months later than the urban group simply because it took longer for the child to be brought to the dentist. The data, however, cannot distinguish between that scenario and the rural patients simply developing decay later.

Practice location does not appear to impact the effectiveness of the FDH program as it relates to decay severity or treatment location. No difference was found between rural and urban practice settings for dmft score or treatment location for decay. This seems to indicate that once access to the FDH program is established, there is a benefit to the patients regardless of the practice setting.

For the Medicaid patients who experienced decay before age 36 months, the First Dental Home program is significantly reducing the severity of decay as judged by the dmft index. The average dmft score for the FDH group was over two points lower than that for the traditional Medicaid recall group. This represents the sparing of two teeth from dental decay. Though clinically significant, this is also financially significant for the state of Texas. A stainless steel crown is currently reimbursed by Texas Medicaid at approximately $150. If two teeth were spared of decay in just 10,000 Medicaid enrollees, the savings would be in the millions of dollars.

Perhaps the most interesting finding of the study also comes from the Medicaid patients who experienced decay before age 36 months. For those patients, the FDH program has resulted in a reduction in the use of the OR for treatment of their decay, such that 30% more of these patients are being treated in the dental office. This not only saves the child from the potentially negative effects of early exposure to general anesthesia, but also affords the greatest amount of cost-savings to the state of Texas. The facilities fees at the hospital for patients requiring dental treatment under general anesthesia in the OR are large. Treating more of these children in-office rather than in

the OR can save thousands of dollars per child. This, combined with the dental treatment cost savings, should be appreciated.

There were several limitations to this project, primarily those typical of cross-sectional and retrospective studies. Additionally, the sample size from which the most exciting conclusions were drawn was small. More research is needed to obtain sufficient patient numbers to draw strong conclusions about the effectiveness of the Texas FDH program, particularly in relation to cost effectiveness. Greater patient numbers could be obtained by using reports generated by the state's own Medicaid billing and reimbursement system. Such an analysis should be performed or at least facilitated by the Texas Medicaid program in order to better analyze and understand both the clinical and financial costs and effectiveness of the Texas First Dental Home program.

CONCLUSIONS

1. Medicaid-enrolled children participating in the FDH program were seen by the dentist nearly five months earlier than prior to the program's inception.
2. Medicaid-enrolled children in rural areas may be experiencing access to care issues, resulting in a delay in the timing of the first dental visit and a delay in decay diagnosis when compared to their urban counterparts.
3. For Medicaid-enrolled children participating in the FDH program who were diagnosed with decay before age 36 months, the severity of decay as judged by dmft was reduced by the equivalent of 2 teeth.

4. For Medicaid enrolled children participating in the FDH program who were diagnosed with decay before age 36 months, the FDH program has reduced the proportion of those children who require treatment in the OR under general anesthesia by 30%.

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APPENDIX

TABLES

Table 1. Caries promoting and protective factors

Caries promoting factors	Caries protective factors
• Previous decay episodes • Hypoplastic enamel • Early *Streptococcus mutans* colonization • High fermentable carbohydrate diet · Especially if in liquid form taken to bed • Visible plaque on teeth • Low socioeconomic status	• Parent assisted brushing • Beginning brushing before age 2 • Use of fluoridated toothpaste • Saliva • Antibacterial therapy

Table 2. Descriptive statistics: Recall vs. FDH, overall study population, N=492

Variable		**Recall N**	**Total N**	**%**	**FDH N**	**Total N**	**%**
Gender	Male	104	199	52.3%	155	293	52.9%
	Female	95		47.7%	138		47.1%
Practice type	Rural	89	199	44.7%	140	293	47.8%
	Urban	110		55.3%	153		52.2%
Treatment location	No decay	127	199	63.8%	194	293	66.2%
	In office	55		27.6%	84		28.7%
	OR	17		8.5%	15		5.1%
Average age 1st visit*		18.2 months			13.4 months		
Average age last visit		49.5 months			45.2 months		
Period of observation		31.3 months			31.8 months		
Average age 1st decay episode*		44.8 months			41.1 months		
Average 1st dmft score*		4.3			5.1		
Time between age 1st visit and age 1st decay episode		26.9 months			26.5 months		

*** Indicates a statistically significant parameter**

Table 3. Comparison: Recall vs. FDH, overall study population, N=492

Variable		**Recall**	**FDH**	**Sig**
Average age 1st visit (months)		18.2	13.4	**<0.0001***
Average age 1st decay (months)		44.8	41.1	**0.05***
Average 1st dmft score		4.3	5.1	**0.02***
Treatment location	In-Office	n=55	n=84	NS
	OR	n=17	n=15	

*** Indicates a statistically significant parameter**

Table 4. Descriptive statistics: Rural vs Urban, overall study population, N=492

Variable		**Rural N**	**Total N**	**%**	**Urban**	**Total N**	**%**
Gender	Male	137	256	53.5%	122	236	51.7%
	Female	119		46.5%	114		48.3%
Visit type	Recall	103	256	40.2%	96	236	40.7%
	FDH	153		59.8%	140		59.3%
Treatment location	No decay	173	256	67.6%	148	236	62.7%
	In office	70		27.3%	69		29.2%
	OR	13		5.1%	19		8.1%
Average age 1st visit*		16.1 months			14.5 months		
Average age last visit		55.6 months			54.4 months		
Period of observation		33.3 months			29.8 months		
Average age 1st decay episode*		46.0 months			39.4 months		
Average 1st dmft score		3.8			5.7		
Time between age 1st visit and age 1st decay episode		31.5 months			26.8 months		

*** Indicates a statistically significant parameter**

Table 5. Comparison: Rural vs Urban, overall study population, N=492

Variable		**Rural**	**Urban**	**Sig**
Average age 1st visit (months)		16.1	14.5	**0.008***
Average age 1st decay (months)		46.0	39.4	**<.0001***
Average 1st dmft score		3.8	5.7	NS
Treatment location	In-Office	70	69	NS
	OR	13	19	

*** Indicates a statistically significant parameter**

Table 6. Descriptive statistics: Recall vs. FDH, decay before age 36 months, N=68

Variable		**Recall N**	**Total N**	**%**	**FDH N**	**Total N**	**%**
Gender	Male	14	23	60.9%	24	45	53.3%
	Female	9		39.1%	21		46.7%
Practice type	Rural	4	23	17.4%	14	45	31.1%
	Urban	19		82.6%	31		68.9%
Treatment location*	No decay	N/A	23	N/A	N/A	45	N/A
	In office	8		34.8%	30		66.7%
	OR	15		65.2%	15		33.3%
Average age 1st visit		14.7 months			14.5 months		
Average age last visit		62.9 months			55.4 months		
Period of observation		37.7 months			38.2 months		
Average age 1st decay episode		30.0 months			31.1 months		
Average 1st dmft score*		6.0			3.7		
Time between age 1st visit and age 1st decay episode		15.3 months			16.7 months		

*** Indicates a statistically significant parameter**

Table 7. Comparison: Recall vs. FDH, decay before age 36 months, N=68

Variable	**Recall**	**FDH**	**Sig**
Average age 1st visit (months)	14.7	14.5	NS
Average age 1st decay (months)	30.0	31.1	NS
Average 1st dmft score	6.0	3.7	**0.007***
Treatment location In-Office	n=8	n=30	**0.012***
OR	n=15	n=15	

*** Indicates a statistically significant parameter**

Table 8. Descriptive statistics: Rural vs. Urban, decay before age 36 months, N=68

Variable		**Rural N**	**Total N**	**%**	**Urban**	**Total N**	**%**
Gender	Male	11	18	61.1%	27	50	54%
	Female	7		38.9%	23		46%
Visit type	Recall	4	18	22.2%	19	50	38%
	FDH	14		77.8%	31		62%
Treatment location	No decay	N/A	18		N/A	50	
	In office	10		55.6%	28		56%
	OR	8		44.4%	22		44%
Average age 1st visit		14.5 months			14.5 months		
Average age last visit		53.2 months			59.6 months		
Period of observation		33.8 months			39.7 months		
Average age 1st decay episode		31.3 months			30.5 months		
Average 1st dmft score		5.5			4.1		
Time between age 1st visit and age 1st decay episode		16.7 months			16.0 months		

*** Indicates a statistically significant parameter**

Table 9. Comparison: Rural vs. Urban, decay before age 36 months, N=68

Variable		**Rural**	**Urban**	**Sig**
Average age 1st visit (months)		14.5	14.5	NS
Average age 1st decay (months)		31.3	30.5	NS
Average 1st dmft score		5.5	4.1	NS
Treatment location	In-Office	10	28	NS
	OR	8	22	

*** Indicates a statistically significant parameter**

FIGURES

Figure 1. Treatment location: FDH vs. Recall, subjects with decay, overall study population, N=171

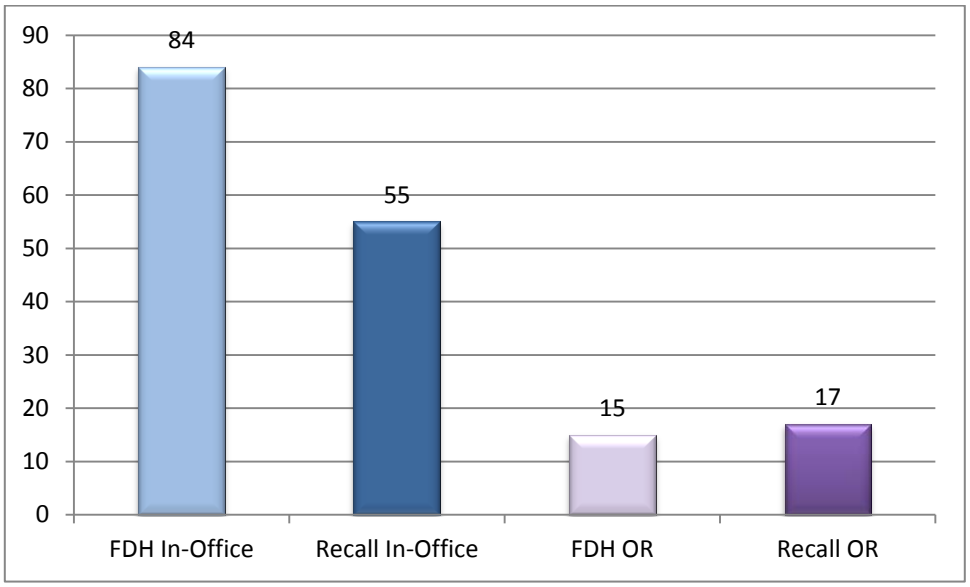

Figure 2. Treatment location: FDH vs. Recall, decay before age 36 months, N=68