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Repeat Full Mouth Dental Rehabilitation under General Anesthesia for Medicaid Eligible Healthy Children who are High Caries Risk

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Repeat Full Mouth Dental Rehabilitation under General Anesthesia for Medicaid Eligible Healthy Children who are High Caries Risk

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Dentistry at Virginia Commonwealth University.

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Abstract

REPEAT FULL MOUTH DENTAL REHABILITATION UNDER GENERAL ANESTHESIA FOR HEALTHY MEDICAID ELIGIBLE CHILDREN WHO ARE HIGH CARIES RISK

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Purpose: To evaluate the treatment of healthy children who are high caries risk and of low socioeconomic status and who require repeat full mouth dental rehabilitation (FMDR) under general anesthesia (GA).

Methods: A retrospective chart review was performed on healthy Medicaid eligible patients who were initially between 18 months - 6 years of age who underwent FMDR under GA in the OR more than once at the Virginia Commonwealth University (VCU) School of Dentistry, Department of Pediatric Dentistry from January 2008 to December 2018. Biographical information for each patient was gathered into a REDCap™ Survey. Statistical analysis, chi-squared test with a significance level set at 0.05, was performed to determine the age, proximity to dental care, level of oral hygiene and preventive services, patient symptoms and treatment rendered during the first OR visit as compared to that rendered at the second OR visit.

Results: A total of 46 subjects were included in the analysis. The majority of patients were referred for GA treatment from an outside provider (n=28, 61%). The median age of patients at

the first GA was 29 months and 55.5 months at the second GA. There was a median of 1.6 years between the two GA appointments. The treatment success rate for treatments ranged from 25% for one surface composites to 94% for SSCs. Of the 125 teeth that received an SSC at GA 1, only five required additional treatment and three were extracted at the second GA. 75% of teeth that received a sealant at the first GA needed to be treated at the second GA.

Conclusion: Results indicated differences in treatment planning strategies among pediatric dentists and suggested more aggressive treatment plans were more appropriate for patients who required advanced behavior guidance to prevent frequent GA exposure.

Introduction

Etiology

Early Childhood Caries (ECC) is the most common chronic disease of childhood, as it occurs five to eight times more frequently than asthma with studies reporting as much as 80 percent of children affected by it.[1,2] ECC is defined by the American Academy of Pediatric Dentistry (AAPD) as the presence of one or more decayed, missing, or restored tooth surfaces in any primary tooth under the age of six.[3] More and more children under the age of six are presenting to dental offices with a more advanced form of ECC otherwise known as Severe Early Childhood Caries (S-ECC). The definition of S-ECC is any sign of smooth-surface caries in a child younger than three years of age, and from ages three through five, one or more cavitated, missing (due to caries), or filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing, or filled score of greater than or equal to four (age three), greater than or equal to six (age five).[3,4] The 1999-2004 National Health and Nutrition Examination Survey (NHANES) reported that 20.48 percent of children between the age of two to five reported to have untreated caries.[4,5] ECC develops soon after primary tooth eruption due to the newly immature enamel with potential enamel defects such as hypoplasia, combined with an immature host system to combat bacteria, primary dentition has an increased susceptibility to disease due to an increased level of cariogenic bacteria that has the ability to colonized.[3,6] The disease develops rapidly on smooth surfaces an having unfavorable impact on a child's dentition which in turns effects their overall development.[7,8] The main oral microflora associated with caries formation include streptococcus mutans, streptococcus sobrinus, and lactobacillus

acidophilus.[9,10] These common oral microflora have the capability to adhere to teeth, metabolize sugars into acids that demineralize tooth structure resulting in a carious lesion.[3,6,7]

Dental caries is considered to be an infectious and easily transmissible disease. [6,11] Maternal transmission, otherwise referred to as vertical transmission, is the most common transmission method. With vertical transmission, the mother has carious lesions that serve as a major reservoir of cariogenic bacteria that are often transmitted through the saliva from the mother to the child.[11] Bacteriocin typing studies provide strong evidence of maternal transmission as a mode of mutans streptococci (MS) acquisition in infancy with as much as 41 percent in some cases and similar studies have demonstrated identical bacteriocin typing patterns of MS isolated from mothers and their infants.[11,12] It was concluded that infants whose mothers have high levels of MS, a result of untreated caries, are at greater risk of acquiring the bacteria earlier than children whose mothers have low levels.[12] Infants acquiring cariogenic bacteria are believed to be at risk for ECC and are at a high risk for future caries experience.[12] Most children who are colonized with MS by age two-and-a-half old develop ECC at four years of age.[13] In an effort to decrease the levels of vertical transmission of cariogenic bacteria, it is recommended that prenatal and perinatal counseling is completed to addresses the health of both the mother and the infant, to encourage the mother to have all caries restored prior to birth of the child and by emphasizing the importance of dental home for the child by age one.[11]

Dental caries is not caused by bacteria alone. Common contributors that place the child at high caries risk include frequent nighttime bottle-feeding or breast-feeding with milk, frequent use of the sippy cup with sugar containing juice, frequent in-between meal consumption of sugar-added snacks or drinks.[14–16] Since some children develop S-ECC at a very young age (18 to 24 months), it is often observed on the maxillary central and lateral incisors due to frequency

of cariogenic drinks via daytime sippy cup or bottle use and nighttime bottle feeding. Children three years of age or younger suffer from severe early childhood caries to primary teeth, defined as any sign of caries to the anterior teeth due to the parent's lack of understanding of the caries disease process.[3,6,7]

Prevention

Studies have shown that with proper preventive and treatment efforts, the development of caries can be thwarted and the overall cariogenic bacterial load can be reduced hence lowering the caries risk for a patient. In order for these preventative and treatment strategies to be effective, it is important that the parent establish a dental home for the patient as soon as the first baby tooth erupts or by age one.[14,17] Periodic examinations are essential, as it provides a perfect opportunity for all providers to conduct a dental caries risk assessment.[18] A caries risk assessment allows dental providers to predict a patient's vulnerability to caries and develop an individualized plan for caries management and prevention. It is recommended that every infant should receive an oral health risk assessment from a primary care provider (pediatrician) or qualified professional by six months of age or at the time when the first primary tooth erupts.[19,20] Each assessment should be based on consideration of clinical findings and caries risk indicators that are associated with direct and indirect causes.[20] Direct causes of caries include microflora or cariogenic bacteria, high sugary and carbohydrate diets, enamel defects and poor oral hygiene. Indirect causes are related to social determinants of health such as socioeconomic status which is influenced by income, race, cultural behavioral and education. Often the patients of lower socioeconomic status as compared to those of higher economic status are burdened with factors that increase their susceptibility to caries and these include: low income, increase

hospitalizations due to unhealthy and unsafe living environments, diets filled with limited nutrients.[21]

Dental Home

The dental profession continues to implement a more interceptive nonsurgical therapeutic model to prevent, treat, and reverse caries lesions, particularly in the early stages.[18] The goal of a dental home is for the dental team work together and develop a plan to address care comprehensively based on clinical findings, radiographic findings, risk assessment, and the patient's cognitive level.[22] The AAPD's Recommendation for Best Practices has expressed the importance of periodic recall exams for it allows adequate time for therapeutic intervention such as fluoride varnish applications for remineralization (reversal of caries) and caries prevention. [23,24] and other fluoride containing material such strategies as Silver Diamine Fluoride for caries arrest (caries control).[8,25,26] In conjunction with theses preventive treatments, the dental team will emphasize the daily use fluoride toothpaste with flossing, provide nutritional counseling, with the objective to reduce the intake of sugary snacks and drinks at home. ECC is preventable with adequate home oral hygiene and dietary practices, studies have shown that patients who attend regular dental recall visits are less likely to experience caries than patients who do not.[23,27]

Barriers to Care

S-ECC prevalence in the United States is between 1 percent and 6 percent.[12] The disease, however, disproportionately affects low socioeconomic populations with patients who are high caries risk and who are insured by Medicaid.[28] One epidemiologic study noted that in the United States (US), ECC remains highly prevalent in poor and near poor preschool children.[27] For patients who have S-ECC and are of lower socioeconomic status, as providers we must

understand the barriers that make changing poor behaviors difficult and place limits on their access to preventative care.[29] Persons of lower socioeconomic status tend to be burdened with "Oral Health Disparities" which is described as various social determinants such as a lack of education and exposure to environmental stressors that ultimately contribute to poor oral health. [21] A national survey revealed that there is a higher prevalence of ECC in poor communities and nearly poor preschool children.[14,21] ECC is 32 times more likely to occur in infants who are of low socioeconomic status, whose mothers have a low education level, and who consume sugary foods.[19] In a study by Shaffer, specific risk factors and how they may manifest their effects on specific tooth surfaces were evaluated and the authors were able to identify associations between separate decay patterns and found it directly related to parental sex, race, and educational level as well as the tooth brushing frequency for the child.[30] Studies have looked at how social and environmental factors that include stress, poor nutrition and low maternal birthweight, may have negative effects on tooth development in the child thus making them more susceptible to rampant caries.[31]

Direct and Indirect Effects of the Disease Process

Rampant caries in children with no other health problems is often associated with decreased overall growth and development. Children with severe ECC may become severely malnourished due to tooth pain resulting in an inability to eat [8] and if left untreated, the effects of ECC manifest quickly to symptoms including spontaneous pain, acute and chronic abscesses, fever, and extra oral swellings.[14,15,31] Studies have also shown a decreased cognitive development due to inadequate nutritional intake of essential nutrients that provide the building blocks for cell proliferation, DNA Synthesis, hormone metabolism, and to systems within the

brain. Brain development is faster in the early years of life compared to the rest of the body, making malnourished children vulnerable to nutritional deficiencies.[32] As a result, poor oral health can result in low self-esteem, missed days of schools, difficulty in concentration and learning, decrease cognitive development, communication, difficulty in swallowing and poor speech and diminish overall quality of life.[15,33] Studies have reported that populations with poor oral hygiene were at an increased risk for respiratory diseases due to elevated oral microflora found in plaque that may be aspirated.[8]

Treatment Strategies

Constructing a treatment plan for patients who are of high caries risk requires considerations based on various contributing factors including medical history, extent of decay, and the ability to accomplish treatment in a safe and humane manner.[34] As previously mentioned, ECC affects children who are of the preschool aged and of the precooperative stage of development. Precooperative behavior is defined as those lacking the ability to cooperative due immature cognitive skills, limited range of coping abilities, limited language skills, brief or negligible attention spans, and virtually no experience coping with stress.[35,36] A child's behavior observed during the appointment, gives an indication of the patient's ability to cooperate for future treatments which in turn contributes to the decision-making process in deciding upon which behavior guidance strategies will be most effective.[37] A majority of pediatric dental patients can be treated in the conventional dental environment without the use of pharmacologic agents, except for the occasional use of nitrous oxide/oxygen inhalation analgesia for the mildly anxious child. [36]

Basic non-pharmacologic behavior guidance techniques such as tell-show-do and voice control are successful with children who have the ability to listen and comprehend. However, since most children with ECC are of the precooperative behavioral stage, they lack the ability to cooperate despite these non-pharmacologic behavioral management techniques. These children will often require more advanced behavioral management such as protective stabilization and/or sedation or general anesthesia.[8,38,39] In the past, treatment under general anesthesia was utilized primarily for the treatment for the medically complex patients who are classified by American Society of Anesthesiologists (ASA) with a physical status of ASA III (systemic uncontrolled).[40,41] However, due to numerous reasons such as concern about the developing psyche of the child patient, parental concerns over taking time off from work and the distance a parent will have to travel for specialty care, [15,37,42] there has been increased parental acceptance of pharmacologic behavior management techniques for healthy patients who are either ASA I (healthy) or ASA II (mild systemic disease).[38] The American Society of Anesthesiologists physical status classification system is a system designed for assessing the degree of a patient's "sickness" or "physical state".[41] Although ASA system does not predict perioperative risk, it does provide a uniform system for communicating between colleagues to ensuring safe care for patients requiring advanced behavioral management techniques.[35,41] Aside from the most common indication for general anesthesia, which is extensive dental needs, behavior management has become the second most common indication for children who are considered to be healthy.[16] Some have contributed this increase in acceptance of general anesthesia for healthy children to a change in parenting styles, the parents own fears and desires, and the patients perceived comfort.[36,38,43,44] A recent survey discovered that parents tend to perceive oral sedation and GA to be less risky, more cost-effective, more comfortable for their child, and more

convenient than in the past, leading to a rise in parental acceptance.[38] Also, as compared to treatment under general anesthesia, treating patients under oral conscious sedation may place practitioners in positions where they are forced to make treatment decisions with no or poor-quality radiographs. According to Nathan, if a child requires more than three oral sedations appointments, general anesthesia is indicated as opposed to oral conscious sedation. General anesthesia then is more of an affordable option due to the extensiveness of treatment resulting in increased chair time, number of appointments, procedure and social costs.[36]

Treatment Under GA in the OR

Addressing caries allows providers to restore the integrity of tooth structure; preventing the spread of infection into the dental pulp; and preventing the shifting of teeth due to loss of tooth structure.[45] Restorative treatment usually consists of removal of caries, followed by restoration of teeth or surgical removal of non-restorable teeth. It provides an immediate solution for patients by restoring the teeth back to normal form and function.[8] However, this approach does little to control the disease, and often 40 percent of patients who present to the OR initially for treatment will experience relapse within the first year due to caries recurrence.[46,47] Berkowitz et al, found that over 50 percent of children treated under GA for dental caries require further treatment at 6-month recall.[16] New caries lesions after comprehensive dental treatment under GA have been reported to affect approximately 22 to 52 percent of children after six months.[48] Restorations involving multiple surfaces placed in younger patients with severe decay had lower survival rates.[49] Studies have evaluated the success rate of individual procedures performed on patients under GA and have reported on the superiority of the stainless steel crown (SSC) over amalgam and composite restorations, the high success rate of vital pulp therapy, and low retention rate of fissure sealants (FS).[14,50,51] Aggressive preventive measures for high risk

children may be less costly than repeated treatment under GA. Twenty percent of patients treated under GA before eruption of primary second molars required additional dental treatment under GA within 38 months of initial treatment.[16,52]

Due to both the high rate of caries recurrence and level of cooperation in the precooperative child, young children with ECC tend to require retreatment under GA.[15] Studies relate the need for retreatment due to factors such as having dental treatment completed under GA or oral conscious sedation (OCS) before the complete eruption of primary dentition, nursing at the time of GA, decrease patient and parent compliance with preventive measures, genetics, and conservative treatments for high caries risk patients due to lack of provider's clinical competence or treatment philosophies.[14,46] The AAPD has reviewed studies on the prognosis of restorations placed in both a clinical and hospital setting. As an organization, the AAPD recommends stainless steel crowns as the treatment of choice for patients who are high caries risk and who require GA since it is the most successful long-term restoration.[14,45] Which brings into question if stainless steel crowns have been historically recommended, why are non-full coverage restorations being treatment plan for these patients?

Repeated dental visits for healthy patients to the operating room (OR) under GA is a rising problem across the nation. Previous literature suggests that the reasons for repeat GA for healthy patients are directly related to caries recurrence and the formation of new carious lesions.[16] A previous study reported poor outcomes for patients diagnosed with S-ECC, noting that 40% of children developed new carious lesions within 12 months post their initial treatment under GA.[46] Studies also noted that in patients with S-ECC, full mouth dental rehabilitation (FMDR) under GA did little to reduce MS levels if mother's MS levels were not addressed. Studies observed suppression of MS for 90 days' post treatment but reported relapse from 90

days to 1-year period.[46] Studies evaluated repeat dental visits for patients including both healthy patients and those who are medically compromised. Currently, there are limited studies that solely focus on the reasons why healthy patients who are treated once under GA often need to return for a second visit. The main benefit for treating the healthy yet extremely uncooperative, fearful, anxious, or uncommunicative child under GA is that it allows providers to aid in the protection of the child's developing psyche and to provide care to patients requiring immediate, comprehensive dental care. A study completed by Eidelman reported on restorative results from patients treated under general anesthesia and determined the quality of treatment performed under general anesthesia was better in comparison to the quality of treatment performed under conscious sedation..[52,53] Additionally, this provides a major benefit to parents who are of low socioeconomic status who present with financial and social burdens that do not afford them the opportunity to take time off from work for multiple appointments. Often patients in this demographic are delayed in receiving adequate care due to multiple failed appointments.[54]

Financial Burden

Although treatment under GA can be very advantageous, it does carry some risks as does any procedure performed under GA, and it is costly in comparison to dental treatment that is completed in the clinical setting. Studies show treatment of ECC can be costly to parents, insurance companies, and taxpayers.[10] In 2010, it was reported that ECC placed a significant financial burden on the taxpayers with a cost exceeding 1.55 billion.[55] Financial data analyzed by health economists investigated the benefit of early intervention of ECC in regards to their demographic and discovered a reduction of 38 percent to taxpayers.[23] As a profession we understand that hospital utilization can become an insurmountable financial burden for the hospital, anesthesiologists, and dentists. Despite the AAPD policy statement and

recommendation for appropriate use of general anesthesia when clinically necessary dental treatment, there are a number of barriers that face pediatric dentists who are credentialed to treat their patients in the hospital. The first involves the reimbursement for anesthesia services utilized for dental treatment on Medicaid-eligible patients is low thus making it difficult for pediatric dentists to obtain operating room time as compared to other services where anesthesia reimbursement is higher.[56] Since these children are usually uncooperative, radiographs are not obtained until taken in the operating room. Therefore, it is difficult to predict the amount of time it will take to complete a case. As a result, if the case extends beyond a certain time, it then leads to increased staffing costs. The hospital system suffers a financial loss especially on cases that require a considerable use of the anesthesiologist services, for the hospital systems make their profit from high-turnover of cases.[56] Additionally, third-party payers deny benefits because they make the determination that dental services are ‘‘not medically necessary” which also contributes to the financial burden.[8]

General Anesthesia Risks

Studies have investigated and proven that use of general anesthesia is associated with risks that may occur during and post-operatively. Common risks include nausea, vomiting, irritability, irregular breathing and not so common coma, brain dysfunction, and death.[57] Investigators have conducted animal studies and evaluated children retrospectively to determine if multiple exposure to general anesthesia has a negative effect on the patient's neurodevelopment. One study by Olsen and associates, found that more than 75 percent of patients younger than age six showed deficiencies in the areas of cognitive and language development post exposure to general anesthesia.[58] Wang and associates conducted a systematic review of neurodevelopmental defects in children as a result of anesthesia and determined that

the number of times of exposure was more significant rather than the age of exposure.[59] Studies have found that between the age of two to four, a single exposure was more likely to produce negative deficits in communication and general knowledge in comparison to those who were never exposed to anesthesia.[60]

Study Aim

This study addresses in particular the reasons why healthy children of lower socioeconomic status return to the OR and how new strategies including more aggressive preventive measures and treatment planning may be necessary to reduce the frequency and need for retreatment. Of particular importance, this study could directly affect how clinicians who treat Medicaid-eligible patients address preventive and treatment planning. In an academic setting, it could present a learning opportunity and encourage discussion amongst other programs to improve preventive and treatment planning strategies for pediatric dentistry training. Although it is advantageous that treatment in the OR under GA provides a learning opportunity for students in that it allows that many restorations can be completed in a single visit, there is much to learn about prevention and treatment planning to avoid repeat visits to the operating room.

It is crucial to educate parents of lower economic status on treatment under GA concerning both the benefits and risks associated with it, and stress the importance of prevention, establishing a dental home with regular recall visits and the establishment of self-managing goals to prevent the recurrence of caries. The goal of this study is to provide useful information for pediatric dentistry programs and pediatric dentistry practices to examine the factors contributing to repeat visits and make recommendations for a standard of care for preventive strategies and appropriate treatment planning for this high caries risk population.

Methods

Study design. This study was a retrospective cohort study on patients who underwent general anesthesia for dental treatment on two separate occasions between January 2008 and December 2018. Data was collected through a retrospective chart review. This study was approved as exempt by the Institutional Review Board at Virginia Commonwealth University (IRB #: **HM20014844)**.

Study setting and participants. Data were collected from dental records of patients of record at VCU Graduate Pediatric Dentistry Clinic via axiUm software (version 7.04.07, Exan Group, Coquitlam, BC, Canada), who have sought dental care at the clinic in the past for treatment under general anesthesia. Once a patient's medical history and dental history have been reviewed, they will be assessed to determine if they meet the inclusion criteria for this study. Patients included is this study were Medicaid eligible, were high caries risk and who presented to VCU Graduate Pediatric Dental Clinic for repeated treatment under GA initially between 18 months - 6 years of age. Both treatments must have taken place between January 2008 - December 2018. Chart review was limited within that period of time due to the implementation of the software system, axiUm which is currently being used for clinical operations. Eligible participants must be considered healthy and of ASA I or II status (Diagnosis of ADHD or Asthma was also considered appropriate).

Collected variables.

To test the study's hypothesis, a retrospective study was conducted. A query of CDT codes was conducted for the D9999 code for all pediatric dentistry patients age 18 months to 6 years of age who had two episodes of treatment in the OR will be conducted. The D9999 code is for "Unspecified adjunctive procedure, by report" a code added to the Treatment Plan for patients requiring treatment in the OR. Procedures had to occur between January 2008 and December 2018. From the data collected, the number of subjects will be determined. Selected charts were then reviewed by hand by two reviewers. From that data, patients who are medically compromised were only seen once were excluded. Data used for the study included the age of patients, stage of dentition, and treatment completed at the first visit (GA 1) and second visit (GA 2). Individual dental procedures were recorded for each tooth as well as dates of first and second GA visit and dates of the initial follow-up appointment after GA were recorded for each patient were enter into an electronic database maintained in REDCap™ (Research Electronic Data Capture).[61]

Teeth were first categorize based on location of the teeth: anterior vs. posterior, maxillary vs. mandibular and then based on the treatment provided. For the first GA, teeth were categorized into three categories: treated at 1st GA, extracted at 1st GA, or deemed to be healthy or not present at 1st GA. Teeth treated at first GA included teeth that received sealants or any type of restoration (detailed below). Teeth were categorized as extracted if they were extracted. Teeth that had no treatment recorded were categorized as healthy or not present.

For the second GA, teeth were categorized into additional categories. Again, teeth could be categorized as "extracted" or "healthy/not present" as before. In addition, if teeth were treated at both the first and the second GA, they were categorized as "Re-treated at the 2nd GA." Teeth that received any treatment at the second GA but were "healthy/not present" at the first GA were

considered “Initial treatment at 2nd GA.” The final category was “Successful” if the teeth were treated at the first GA and were not treated at the second GA. This would include teeth that had exfoliated between the GA treatments.

All restorations were completed with similar material utilized in the VCU Department of Pediatric Dentistry. Anterior and posterior one or multi-surface composites restorations were completed using TPH Spectra Composite, (TPH Spectra, Dentsply, Charlotte, North Carolina). Anterior full coverage restorations were completed with the following: Composite Strip Crowns (Pediatric Strip Crown Forms, 3M ESPE, St. Paul, Minnesota) or (Anterior Strip Crown Forms, Nowak Dental Supplies, Carriere, Mississippi). Prefabricated Pre-Veneered Crowns (NuSmile Pre-Veneered Crowns, Houston, Texas), and Zirconia (Prefabricated Zirconia Crowns, SPRIG, Loomis, CA). Stainless steel crowns were placed on posterior teeth (Pre-Contoured Stainless steel Primary Crowns, 3M ESPE, St. Paul Minnesota). All full coverage crowns were cemented with Fuji 2 cem (GC America FujiCem 2, Alsip, IL). The exact cause of failure was not investigated.

Calibration.

To calibrate, two independent examiners met for an initial training session to review the study aims and design. At this meeting, the parameters of the study were discussed. A uniform method for data collection was establish to ensure consistency in the data collection. After initial calibration, the patient records were divided and reviewed by one examiner.

Statistical methods. Results were summarized using descriptive statistics. Chi-squared tests were used to determine differences in treatment rates.

Results

A total of 46 subjects were included in the analysis. There were slightly more males than females (57% versus 43%). Participants were predominantly Caucasian (n=19, 41%) followed by African American (n=12, 26%), Hispanic (n=7, 15%), and Other/Multi-racial (n=8, 17%). The majority of patients were referred for GA treatment from an outside provider (n=28, 61%).

Table 1: Patient Characteristics (n=46)

	n	**%**
Gender		
Male	26	57%
Female	20	43%
Race/ethnicity		
Caucasian	19	41%
African American/Black	12	26%
Hispanic	7	15%
Other/multi	8	17%
ASA Classification		
ASA I	22	48%
ASA II	24	52%
Distance traveled for treatment		
Pediatric Provider within 10 Miles of Primary Zip code Yes	31	67%
Pediatric Provider within 10 Miles of Primary Zip code No	15	33%
Patient Source		
Referred from Outside Provider Yes	28	61%
Referred from Outside Provider No	15	33%
Unknown/Missing	3	7%
GA follow-up appointment		
Attend 2-3 Week OHI (GA 1)	15	33%
Attend 2-3 Week OHI (GA 2)	18	39%
	Median	**IQR**
Age at First GA (in months)	29	25-39
Age at Second GA (in months)	55.5	47-63
Time Between GA (in days)	600.5	416-897
Time until Follow-up (GA 1) (in days)	48	20-340
Time until Follow-up (GA 2) (in days)	21	14-190

The median age of patients at the first GA was 29 months (IQR: 25-39) and 55.5 at the second GA (IQR: 47-63). There was a median of 1.6 years (600.5 days) between the two GA appointments (***Table 1***).

At the first GA, the majority of the treatment included the maxillary anterior teeth (n=121 teeth, 44% of maxillary anterior teeth), and maxillary and mandibular posterior teeth (n=112, 61% and n=129, 70% respectively). Of the teeth extracted at the first GA, the majority (74%) were maxillary anterior teeth (n=54, 20% of maxillary anterior teeth). Only two permanent molars were treated as the vast majority of patients probably did not have erupted permanent molars present at the first GA. A complete summary of the treatment that occurred in GA 1 and 2 is presented in ***Table 2***.

Table 2: Summary of Treatment Status at First and Second General Anesthesia (GA) Appointment

	1st GA			2nd GA				
Tooth Type	Treated at 1st GA	Extracted at 1st GA	Healthy/Not Present	Re-treated at 2nd GA	Initial Treatment at GA 2	Extracted at 2nd GA	Successful	Never treated
Maxilla								
Anterior	121, 44%	54, 20%	101, 37%	33, 12%	22, 8%	15, 5%	77, 28%	75, 27%
Posterior	112, 61%	7, 4%	65, 35%	48, 26%	57, 31%	7, 4%	61, 33%	4, 2%
Permanent	1, 1%	0, 0%	91, 99%	0, 0%	7, 8%	0, 0%	1, 1%	84, 91%
Mandible								
Anterior	21, 8%	12, 4%	243, 88%	4, 1%	24, 9%	9, 3%	17, 6%	210, 76%
Posterior	129, 70%	0, 0%	55, 30%	57, 31%	43, 23%	11, 6%	68, 37%	5, 3%
Permanent	1, 1%	0, 0%	91, 99%	0, 0%	8, 9%	0, 0%	1, 1%	83, 90%

At the second GA, 12% of the maxillary anterior teeth had to be treated for a second time, an additional 8% needed to be treated for the first time, and 5% needed to be extracted. Over half of the maxillary anterior teeth were untreated at the second GA, half of

which had successful treatment from the first GA (n=77, 28%). These would also include teeth that were exfoliated before the second GA. Mandibular anterior teeth had lower rates of treatment with only 1% needing to be re-treated, 9% being treated for the first time, and 3% being extracted. Posterior teeth received the most treatment at the second GA, with 98% of maxillary posterior teeth receiving some form of treatment and 97% of mandibular. Roughly a quarter were treated for the second time (26% of maxillary and 31% of mandibular) and another quarter were treated for the first time (31% of maxillary and 23% of mandibular). Only 18 had to be extracted at the second GA (4% of maxillary and 6% of mandibular). Approximately a third maintained successful treatment from the first GA (33% of maxillary and 37% of mandibular). See **Table *2*** for summary of second GA.

Treatment success was determined by teeth that were treated at the initial GA but did not need to be treated again at the second. This was based on a total of 478 procedures (note some teeth had multiple procedures). The success rate for treatments ranged from 24% for one surface composites to 94% for posterior stainless steel crowns. Of the 125 teeth that received a stainless steel crown at GA 1, only 5 required additional treatment and 3 were extracted at the second GA. For those teeth requiring pulp therapy, indirect pulp therapy (IPT) was successful for 89% of the 79 instances, therapeutic pulpotomy (n=3) with 67% success and the pulpectomy (n=5) procedure was 75% successful (**Table *3***). For anterior restorations, three types of full coverage restorations were evaluated. The zirconia crown, the two types used were NuSmile® and EZPedo®. As a group, the zirconia crowns were 92% successful. The NuSmile® crown consisting of a metal crown with an esthetic white facing had a success rate of 58%, followed by the composite strip crown at 46%.

Table 3: Treatment Success Rates

Treatment	Total Performed	Success Rate
One Surface Composite Posterior (OSC)	88	24%
Multi-Surface Composite Posterior (MSC)	37	35%
Sealants on Primary Molars	53	25%
Indirect Pulp Therapy (IPT)	79	89%
Therapeutic Pulpotomy	3	67%
Pulpectomy	4	75%
Stainless Steel Crown (SSC)	125	94%
Composite Strip Crown (CSC)	24	46%
NuSmile	12	58%
Zirconia	53	92%

In order to assess the effectiveness of preventative sealants placed on primary molars, the treatment at the second GA was compared between teeth that were sealed at first GA and those that were not (after excluding teeth that were treated at first GA). Permanent molars were excluded due to unlikeliness of presence at the times of GA. No sealants were placed on anterior teeth at the first GA. Between the 70% (maxillary) and 73% (mandibular) of posterior teeth that received sealants at the first GA required restorative treatment at the second GA (**Table *4***). Additionally, at the second GA, anterior teeth not treated at the first GA were restored or extracted 26% of the time in the maxilla and 13% in the mandible. For posterior teeth that got sealants at the first GA, between 70% (maxillary) and 73% (mandibular) had to be restored or extracted at the second GA. For posterior teeth that were not sealed at first GA, between 85% (maxillary) and 89% (mandibular) had to be restored or extracted at the second GA. The increase in treatment necessary at the second GA was statistically significant (p-value=0.0425). Results are presented in **Table *4*/Figure *1***.

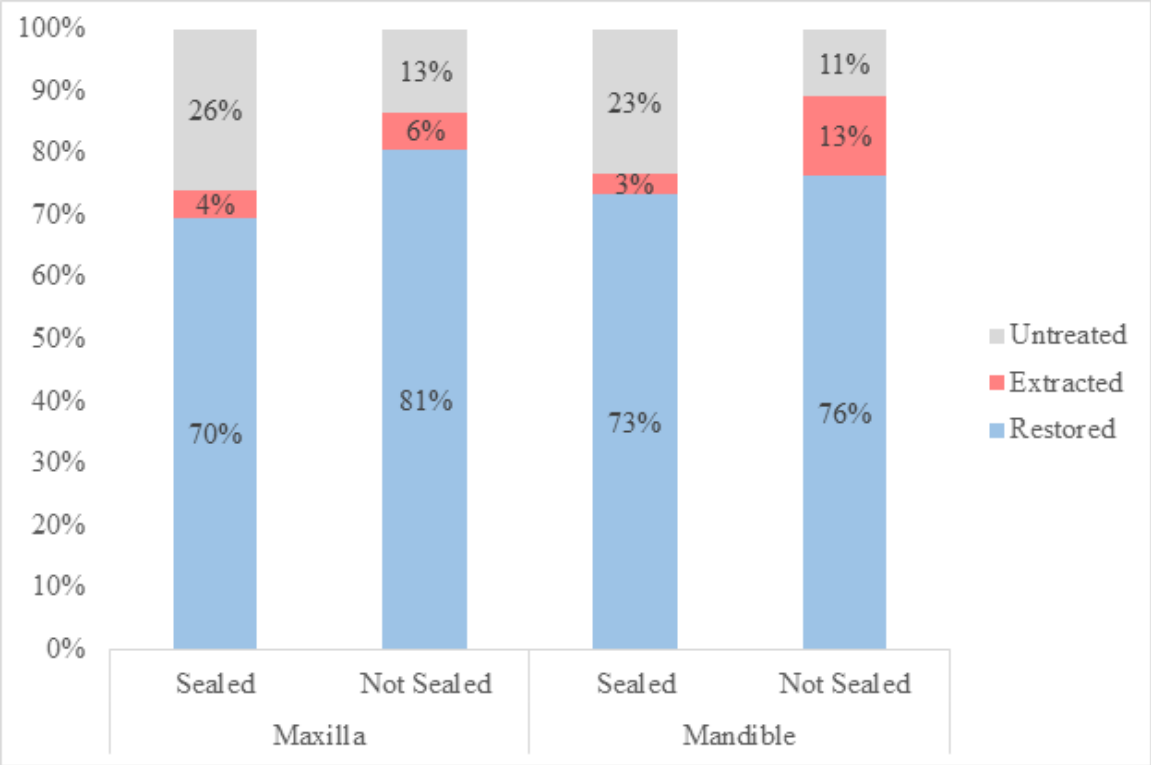
Table 4: Treatment Summary based on Use of Preventative Sealants

	Sealed at First GA				Not Sealed at First GA		
Tooth Type	Restored at GA 2	Extracted at GA 2	Healthy/Not Present		Restored at GA 2	Extracted at GA 2	Healthy/Not Present*
	Maxilla				Maxilla		
Posterior	16, 70%	1, 4%	6, 26%		54, 81%	9, 4%	9, 13%
	Mandible				Mandible		
Posterior	22, 73%	1, 3%	7, 23%		42, 76%	7, 13%	6, 11%

*This includes teeth that were sealed for a second time at the second GA

**The increase in treatment necessary at the second GA was statistically significant (p-value=0.0425)

Figure 1: Treatment at Second GA Based on Jaw and Use of Sealants at First GA for Posterior Teeth



As aforementioned, assessing behavior and determining the ideal treatment setting for each patient, should be an ongoing assessment. However, it is imperative that at the treatment

planning session that a pre-operative assessment is conducted to ensure the patients' needs are addressed appropriately. If advanced guidance techniques are necessary, that they are documented within the patient's charts. When reviewing the reasoning's for use of GA for patients, no significant differences were found in regards to indications selected between the first versus second GA appointments. Overall, the main indication for justification for GA was lack of cooperation (**Table *5***).

Table 5: Justification for Use of General Anesthesia (More than one could be indicated)

Justification for General Anesthesia				
	GA1 #	GA1 %	GA2 #	GA2 %
Who cannot cooperate due to a lack of psychological or emotional maturity and/or mental, physical or medical disability	42	91%	32	70%
For whom local anesthesia is ineffective because of acute infection, anatomic variations, or allergy	1	2%	0	0%
Who are moderately to extremely uncooperative	25	54%	35	76%
Who are verbally uncommunicative because of psychosocial, medical, or cultural situations?	16	35%	8	17%
Who require significant restorative and/or surgical procedures	31	67%	25	54%
For whom the use of GA may protect the developing psyche and/or reduce medical risk	34	74%	31	67%
Who require immediate, comprehensive oral/dental care (e.g., dental abscess threatening patency of the airway or other anatomical structures)	3	7%	3	7%
Who have demonstrated the inability to respond to other available behavior guidance techniques	13	28%	17	37%
Patient travels long distance	12	26%	13	28%

Discussion

Repeat general anesthesia appointments for the treatment of S-ECC is a major problem that is more common in patients who are of low socioeconomic status. A number of studies have looked at the reasons why children (to include those with special healthcare needs) require repeat visits for full mouth dental rehabilitation (FMDR) under general anesthesia (GA).[51,52] There is a limited amount of information available to address the reason why healthy Medicaid eligible children are more likely to be seen for multiple FMDR under GA.[16] Since repeat exposure to anesthetic gases can result in neuro-developmental issues[58], the authors of this study focused on the number of repeat FMDR under GA cases performed on healthy Medicaid eligible children to determine methods of treatment planning and preventative strategies to help prevent repeat visits to the operating room for dental treatment.

According to the 2019 US Census Bureau for Virginia, the demographic distribution for the State of Virginia is Caucasians at 69.5 percent, African Americans at 19.9 percent, and Hispanics at 9 percent, which happened to align with the patient demographics of patients referred to our pediatric dental practice. The majority of patients that sought treatment were Caucasian (41 percent), African American (26 percent) and Hispanic (18 percent). We expected our findings to reflect higher percentages in our patient demographics for African American and Hispanic populations, for these patients tend to have a higher caries experience and increased prevalence of oral diseases versus Caucasian populations.[21,62] In our study, 67 to 89 percent of patients had a pediatric dentist within 10 to 25 miles of their zip code. The majority of our

patient population (61 percent) were referred from an outside provider. Our study did not investigate the reason for referral however, one can assume the following factors, the referring dentist is: a general dentist with inadequate training in behavioral management techniques and/or does not have operating room privileges. Due to the fact that the study took place in a state academic institution, the patient pool contained referrals from all across the state, mostly for children who are from families of lower socioeconomic class and are therefore eligible for Medicaid. Patients of lower socioeconomic class, regardless of race, all face the same barriers, which is why our population is more reflective of the VA population, than of previous studies.

Even though financial assistance for dental services are provided to low income families, benefits are often underutilized, undervalued, or unknown to them.[21,62] This study discovered that a number of patients who required a second FMDR under GA did not come in for their regular six-month preventive visits. One study had reported that by age one, 99 percent of Medicaid eligible children had received a checkup from their pediatrician however, less than 2 percent had seen a dentist.[7] It is important to note that when patients do not attend regular dental visits, the opportunity to perform active surveillance and management of dental caries diminishes resulting in ECC and S-ECC. According to our study, after the first and second GA appointments only 33 percent and 39 percent respectively presented to the clinic for their 2 week follow-up appointment (**Table *1***). This is in agreement with Foster et al, who reported that 61 percent of the population failed to attend their immediate 2 week post-operative appointment for reinforcement of hygiene and dietary counseling.[63] According to a study by Roberts's, patients commonly missed their appointment after GA because patients did not see the importance of maintaining recall visits. One could look at the education level and lack of health literacy as major factors contributing to lower follow-up visits.[64] Additionally, the majority of the patients

(61 percent) in our study were referred from an outside provider. As mentioned before, this could also explain the low return rate for the 2-week postoperative follow-up visit, as patients may or may not have returned to their dental home.

It has been shown that routine and preventative services decrease caries prevalence, thus the importance of a dental home by age one.[22] Regular recall visits allow providers to monitor caries development/progression and educate parents on proper diet, oral hygiene, and provide fluoride therapy.[23] Currently, the AAPD has recommended protocols and guidelines for caries prevention that are proven to reduce new carious lesions by 43 to 65 percent, improving overall oral health, eliminating detrimental effects of caries including malnutrition due to dental pain by 38 to 77 percent.[65] Methods to overcome barriers that prevent parents of low socioeconomic status from receiving routine and preventive services should become the focus of advocacy groups and our legislative leaders. However, in our study most reported that there was a pediatric dentist within a 10 to 25 miles' radius, which leads us to believe that access to care has become less of an issue and attitudes and/or behaviors are becoming the primary barrier to reducing caries recurrence. In a study by Sheller, the authors discovered via a post-GA questionnaire that the majority of caregivers (64 percent) did not decrease the frequency of snacks, 45 percent continued bottle use at bedtime or during naps, but the majority of parents agreed that GA was the best decision for their child.[16]

Limiting the age range to 0 to 72 months allowed our study to focus on how development and behavior influence S-ECC. Providers had the opportunity to examine a patient's treatment plan and behavior before the initial and second GA appointment. The reasons, both before the first and second GA appointments, for treating patients under GA did not vary greatly. The most common indication (91 percent) for general anesthesia was for those "who cannot cooperate due

to a lack of psychological or emotional maturity and/or mental, physical or medical disability. The least common indication for general anesthesia was for “those whom local anesthesia is ineffective because of acute infection, anatomic variations, or allergy”. Although no significant differences were found in regards to indications selected between the first and second GA appointments, it was interesting to observe that 76 percent of patients who presented back for the second time, were considered “moderately to extremely uncooperative”. We found these results to be consistent with previous studies that note that behavior, more specifically lack of cooperation, was the most common indicator for repeated treatment in the operating room.[37] The aforementioned change in parenting styles, parental acceptance, honoring parent request of services due to parental own personal anxiety has over time contributed to a change in child temperament which could explain parental acceptance to multiple exposure to general anesthesia.[38,44,66] Also to account for the increased preference for the use of GA, a 2004 survey reported a change in behavior management teaching style in pediatric dentistry programs citing 69 percent plan to devote the same amount of time to teaching general anesthesia techniques, while 31 percent reported that they had plans to devote more of their curriculum to teaching and providing treatment to children under GA.[67] There are obvious benefits to performing treatment under GA however, one can argue that risks in regards to development may not outweigh the benefits, especially in a healthy population of children. Therefore, these risks should be thoroughly explained to parents which can be challenging in individuals with limited health literacy.

We found our results to be consistent with previous studies that highlight children with S-ECC often have caries on maxillary anterior teeth. Our study revealed the patient's initial visit to GA to have a mean age of 29 months, which coincides with Kholer who reported 89 percent of children had acquired MS by the age of two (24 months).[68] Most of the patients in our study had

caries present on their maxillary anterior teeth (44 percent) at the time of the first general anesthesia appointment requiring restorative treatment. Of the teeth that required extractions at the time of the first GA appointment, 20 percent of teeth were anterior maxillary teeth. Studies have correlated the high occurrence of caries on anterior maxillary teeth due to behaviors.[69] Most practitioners were able to dictate associated habits that included poor oral hygiene habits, unsupervised brushing, cariogenic diets, high juice intake and use of sippy cups, nighttime breast and bottle feeding.[70] Studies have shown that the positioning of the tongue around the nipple allows for milk to be in contact for prolonged periods of time with the maxillary anterior teeth making them more susceptible to the negative effects of cariogenic dietary beverages.[71] This finding also verifies the importance of early intervention before the age of 2 to prevent caries formation, supporting the AAPD recommendation of the year one visit.[23]

At the second GA appointment (mean age of 55.5 months), children were found to have new carious lesions detected and retreatment of previous conservative restorations (for example one or multi-surface composite restorations) required replacement with a more aggressive full coverage restoration. Consistent with a study by Almeida's et al, the authors described the average time between detection of new caries and treatment performed to be 17.7 months. We found the average time between treatment to be 18 months.[72] The study described the average time of relapse to be within 2 to 4 years in 55 to 79 percent of patients treated under GA. By the second GA appointment, 25percent of maxillary anterior teeth required treatment or retreatment. We also found that for maxillary teeth, 64 percent required treatment or extractions at the initial visit, and 25 percent required initial treatment, retreatment or extraction at the second GA visit. When evaluating anterior crowns, we compared composite strip crowns (3M strip crown/Nowak strip crown with TPH composite), Nu Smile ® metal back crowns, and NuSmile ® /EZPedo ®

zirconia crowns. We observed that zirconia crowns (ZC) were shown to be superior to both composite strip crowns (CSC) and Nu smile metal back crowns (NMB) showing a 92 percent success rate in comparison to CSC and NMB which were at 46 percent and 58 percent respectively. However, our study revealed that all anterior crowns were superior to the one or multi-surface composites. Our results were similar to that of Amin and associates, who reported strip crowns and crowns to have a combined success rate of 92.4 percent.[48,73] Previous studies have reported a relapse after restorative treatment after GA to be 40 percent [25] , indicating limited changes to hygiene and dietary habits. Mandibular anterior teeth demonstrated lower susceptibility to caries than maxillary anterior teeth. Rates of treatment for mandibular anterior teeth at the second GA were only 1 percent requiring re-treatment, 9 percent being treated for the first time, and 3percent requiring extraction. While the maxillary incisors have been shown to be the more vulnerable, the mandibular incisors are thought to be "protected" from the negative effects of these dietary habits due to the presence of submandibular and sublingual salivary glands and the protective positioning of the tongue.[74]

When evaluating treatment success versus failures of posterior teeth, our results were relatively consistent with previous studies. We found posterior stainless steel crowns to be very successful (94 percent) in comparison to one surface (24 percent) and multi surface composites (35percent). A similar study has shown that patients who received one-surface occlusal composite resin at the first GA appointment then at the second GA required 17.9 percent required replacement of the existing composite resin with or a received new composite restoration and 68.6 percent were replaced with a SSC.[48] The treatments with higher success rates (full coverage restorations for high caries risk patients) also coincide with the recommendations set by the AAPD.[75] It is important that we adjust our treatment strategies to be

favorable to high-caries risk patients, such as full coverage restorations versus more conservative treatment due to daily barriers to care relating to financial, social, and environmental barrier.[76]

The success of pulp therapy was in agreement with other studies that indicate the success of indirect pulpal therapy to be 89 percent and pulpotomies at 67 percent.[77] When evaluating the success of sealants placed, we excluded evaluating sealants placed on the first permanent molars due to these teeth not being present at the first GA (mean age 29 months). We were able to evaluate sealants placed on the primary molar teeth and determine whether or not sealants placed on posterior primary teeth required retreatment or additional treatment at the second GA. Not every patient who was seen in the OR was recommended for sealants and we discovered that between 76 percent of mandibular and 81 percent of maxillary unsealed teeth required restorative treatment and 4 to 13 percent respectively required extraction at the second GA (**Table *4***). Although studies remain inconsistent with supporting the use of preventative sealants on primary dentition[78] we discovered that even though the success rates for sealed primary molars was low, the success rate of unsealed molars was even lower.

Limitations

There are several limitations to our study. This was an observational study with no control group therefore no causation can be concluded. The study only included patients limited to a specific high risk population. Information on patients visits, or lack thereof, between the two GA appointments was limited which is due to multifactorial reasons. A conclusion cannot be made for the reasons associated with a second GA visit due to a lack of comparison to other patients within the same population.

In an academic setting where there is often a lack of continuity of care by providers and inconsistent documentation between providers throughout the years. The majority of notes taken regarding GA appointments before 2015 were done so using a different template which increases inconsistency in record keeping and the potential for missing clinical data. For the majority of patients in the initial GA consultation, the patient's reason for GA was not documented clearly. In these instances, evaluators assumed a lack of cooperation based on patient age and Frankl score noted during the visit.

As for the success of the anterior full coverage restorations, the low success rate for CSC could be due to provider technique since this type of restoration is more technique sensitive than the NMB and ZC restorations.

Other missing clinical data may include wrongfully charted or uncharted treatment rendered or possible missing charts that were not properly documented with the D9999 Unspecified code. There was seven percent unknown to whether a patient was referred from an outside provider or was patient of record. Also to explain our patient demographics, we reviewed whether or not the patients had a one-year visit or a post-operative follow-up appointment both of which were difficult to assess due to the fact that the majority (61 percent) of our patients included in our study were referred from an outside provider

Summary

We know from studies that restorative treatment does not stop the progression of the disease [62] which then places a great deal of responsibility on dental practitioners to provide more thorough oral hygiene instructions, address nutritive habits and provide anticipatory guidance for this patient population. With the great variability in communication styles and treatment styles,

it is unclear at the time by reading the chart notes if a proper preventive plan was in place for the patient. In some notes, behaviors/daily routines documented at the initial visit include breastfeeding at night, continuous snacking throughout the day, drinks juice or healthy fruits were noted, but consistency in reporting did not occur in all charts which would have been beneficial for this study.

Conclusion

- Although the majority of the notes did not dictate the reasons for the reoccurrence of the disease, it is believed that it could be due to multiple factors. The median age for the first GA was 29 months and the second at 55 months thereby stressing the importance of the age one visit and implementation of preventive measures to reduce future caries.
- Access to care was not the issue since patients were able to have treatment completed under GA in the OR more than once. However, restorative care does not stop the disease process and the issue becomes prevention and how to develop preventative strategies that will ensure that patients do not develop new carious lesions.
- Regardless of race, patients of lower socioeconomic status faced similar barriers. Therefore, institutions/clinics that receive referrals of Medicaid eligible patients should have systems in place to help patients overcome the barriers that prevent optimal dental care and preventative services.
- Our findings also emphasized the importance of regular evaluation of treatment plans among providers and their overall success. It is also imperative to develop treatment plans that are appropriate for patients who are high caries risk.
- Aggressive treatment strategies such as full coverage restorations and extractions were more successful and definitive for patients who are high caries risk and of lower socioeconomic status to reduce the need for retreatment under GA in the OR.

- Sealants had a protective effect since placing a sealant on the occlusal surfaces of primary molars in high caries risk patients at GA1 can reduce the amount of treatment necessary at the GA2 by as much as 23-26%.

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