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# Parental Acceptance of Silver Diamine Fluoride Treatment for Carious Lesions

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Author Details

*Mitchell Miller, Kelly Hart, Maria A Levi-Minzi*, Jennifer Chung, Judith Chin, Oscar Padilla, Romer Ocanto*

*Nova Southeastern University, United States*

*Corresponding author

Maria A Levi-Minzi, Nova Southeastern University, College of Dental Medicine, 3301 College Avenue, Ft. Lauderdale, FL 33314, United States

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## Abstract

### Objectives

The purpose of this study was to determine parental acceptability of the use of Silver Diamine Fluoride (SDF) as an alternative treatment for carious legions. In addition, we examined potential factors influencing higher levels of SDF acceptance.

### Methods

Project was approved by the institutional review board. Parents of patients receiving care at Nova Southeastern University's dental clinics were asked to review an educational document related to the use and side effects of SDF; surveys were then distributed to assess willingness to use this treatment for their child. SDF acceptance was measured by mean scores on the SDF Feasibility Questionnaire; higher scores indicated higher levels of SDF acceptance. Descriptive statistics were calculated to describe the sample (N=160) in terms of demographic and patient characteristics, and previous behavioral and dental visit characteristics. Bivariate logistic regression models were used to predict higher SDF acceptability by patient demographics, and behavioral and dental visit characteristics.

### Results

Over half of the sample was male (62%), and ages 1-10 (65%); 38% were diagnosed with Autism Spectrum Disorder (ASD). In terms of dental history, 51% reported having a cavity, and 27% had been treated with nitrous oxide, 19% had oral sedation and 14% had general anesthesia. Those reporting the previous use of oral sedation had two times higher odds of SDF acceptance score (OR 2.2; [95% CI 0.99, 4.85], p=.05). Demographics, diagnosis of ASD, previous cavities and behavior during treatment had no impact on SDF acceptance.

### Conclusion

Findings suggest that SDF was more acceptable among those with a history of oral sedation, perhaps because SDF is a less time-consuming and risky procedure. In addition, given that oral conscious sedation does not guarantee cooperation and can take multiple, time consuming appointments, SDF may be a more feasible alternative.

**Keywords:** Dental; SDF; Autism; Survey; Parental perception

## Introduction

According to Sharma, et al. [1], anxiety and fear are the most common emotions a child experiences when entering the dental office. In a study of 1,420 subjects completed by Locker, et al. [2], it was found that 16.4% of children enter the dental office with some amount of fear or anxiety. Behavior management techniques, interim restorative options, protective stabilization, nitrous oxide, oral conscious sedation, and general anesthesia are just some of the tools pediatric dentists use to manage children experiencing dental fear and or anxiety.

Currently, the conventional route of treating a carious lesion is to

anesthetize the tooth, remove the decay, and restore the tooth back to a healthy state with a filling material or full coverage restoration. This method, however, can be a traumatic and time-consuming process for a pre-cooperative child, especially if the child has multiple cavities present.

In managing uncooperative children, there are multiple ways including advanced behavior management techniques, modified scheduling of dental appointments, and the use of different dental materials. When traditional restorative care may not be an option, the American Academy of Pediatric Dentistry [3] guidelines recommend the use of an interim therapeutic restoration (ITR) or the atraumatic restorative technique (ART) in which a fluoride releasing glass ionomer is placed in an open cavity to seal it off from the oral environment. These restorations are utilized to delay the disease process prior to placing a definitive restoration [4]. The success rate of these methods, however, are questionable. A meta-analysis completed by van't Hof, et al. [5] showed that although the single surface applications of ART tend to be successful, the more surfaces affected by the caries, the less successful ART becomes.

In recent years, silver diamine fluoride (SDF) has become an available ground-breaking product in pediatric dentistry in the United States. This antimicrobial and caries arresting agent Mei, et al. [6], has been used for many years in Brazil, Argentina, Japan, and Australia [6]. In August 2014, SDF was introduced and approved as a desensitizing agent by the FDA for use in the United States, and has since been gaining popularity as a caries control agent for treating early childhood caries. The FDA approval as a desensitizing agent is the same as fluoride varnish.

When applying SDF to a cavity, it arrests the active carious lesion and reduces the risk of new caries without the use of anesthesia and a drill. Without the removal of caries, it helps resist the acid produced by the bacteria and promotes the formation of hydroxyapatite and fluorapatite creating a hardened surface, inhibiting the growth of the carious lesion [7].

SDF may be indicated when a child is: at an extreme caries risk; behaviorally or medically challenging; requires multiple visits to treat all cavities; has difficult cavities to treat; and/or is has limited access to care (Horst et al, [8], please also refer to the Policy on the Use of Silver Diamine Fluoride for Pediatric Dental Patients, AAPD [9]). The protocol states that the success rate of SDF is likely dependent upon the dryness of the tooth along with the length of time the SDF has had to soak into the lesion. Therefore, as long as there is good isolation and adequate length of contact with the caries, SDF has a high success rate [8]. This is significant because it can allow uncooperative patients to be treated successfully without the use of anesthesia and a drill, potentially providing a less traumatic visit to the dentist. Application of SDF requires isolation of the carious lesion with cotton rolls, isolation apparatus i.e. Isodry, gauze and then allowing the SDF to soak into the lesion for 1-3 minutes and the procedure is complete.

Zhi, et al. [10] showed the effectiveness of SDF to arrest carious lesions and create a hardened surface. Results not only showed the effectiveness of inhibiting the growth of a carious lesion, but also confirmed that with multiple applications of SDF, the success rate increases. SDF has a success rate of over 90% when multiple applications are completed, whereas the glass ionomer evaluated in this study had a success rate of 82%. Similarly, Nishino [11] found that silver fluoride was effective in stopping the lateral progression of dental caries. Duangthip, et al. [12], found that annual or three consecutive weekly applications of SDF is the most effective. Further research is being conducted to determine the most effective amount of time is between applications, but it has been documented that many clinicians use a 1 and 3-month follow-up, with continuation at six-month recall visits [8,9].

Given the simplicity of applying SDF and the lack of need for drilling or anesthetic injection, it can serve as an ideal treatment option for children experiencing fear and anxiety during dental visits [13]. Moreover, SDF could be useful alongside other behavior management techniques to decrease the most common emotions a child feels when entering the dental office (i.e. anxiety and fear) [1]. With SDF, although tooth structure is not restored, appointments are potentially shorter, less instruments need to be used, and the procedure can be more simplistic when compared to other treatment options [14]. This also can delay or eliminate the need for oral conscious sedation and general anesthesia on a case-by-case basis.

The COVID-19 pandemic and its associated lockdowns also presented many challenges within the field of dentistry from limited access to face-to-face dental services, access to and changing guidelines surrounding PPE, and staffing, while adding another layer of risk analysis to aerosol producing procedures [15]. The need to think outside the box with the use of teledentistry and less invasive treatments such as SDF increased during the pandemic [16].

Despite these advantages, SDF will turn the carious lesion a prominent black or brown color after application. This is one of the major disadvantages to its application. Other side effects may include transient staining of the mucosa or skin causing a "temporary tattoo." Although uncommon, mild irritation and burning to the gingival mucosa have also been reported. According to Llodra, et al [17], three of the patients in their study presented with a small, mildly painful white lesion but they reported that within 48 hours the lesions disappeared. Silver allergy is also contraindication to SDF application [18]. Given these drawbacks, it is possible that parents or other caregivers may not be willing to accept the use of SDF.

Recent research conducted in Canada focusing on the experience of parents of patients who were treated with SDF (N=40) found that caregivers trusted the recommendation of the dentist to administer the treatment. Parents still preferred SDF to fillings [19]. Similarly, a qualitative study examining parental concerns related to the use of SDF (N=43) identified the location of the cavities and visibility of the staining would influence their decision to use SDF [20]. Other quantitative research among parents in Saudi Arabia found a significant difference in acceptance depending on tooth location. It was more accepted for use in posterior over anterior teeth [21]. Despite these findings, few quantitative studies to date have examined SDF acceptance among parents in the U.S. The purpose this study is to examine parental acceptability of SDF treatment for their children by measuring patient demographics, characteristics, and parental perception.

## Methods

This study was approved by the Nova Southeastern University IRB (protocol numbers: 2017-576 and 2017-587), and informed consent was received from all subjects. Parents of patients being seen at NSU's Mailman Segal, Joe DiMaggio and KID dental clinics, were asked by a pediatric dental resident to participate in the study. The Mailman Segal Center (MSC) Special Needs Dental Clinic facility houses one dental operatory within a decorated space tailored to children with special needs with an emphasis on ASD. The clinic is equipped to provide comprehensive pediatric dental care to children with ASD from infancy to late childhood.

Upon receiving informed consent, parents were educated about the use of SDF and its benefits and side effects through an information sheet containing images of SDF treated teeth. In addition, the pediatric dental resident provided the parent with a verbal explanation of SDF use, including how and when it is used and it side effects. Parents were also given the opportunity to ask the resident questions.

After reading the educational document, parents were given a survey which collected demographic and patient characteristics (age, gender, race, ethnicity), history of dental visits and fillings, or previous treatment requiring use of physical restraint, nitrous oxide, sedation, or general anesthesia. SDF acceptance was measured by a mean scale score on the SDF feasibility questionnaire adapted from

Crysta,l et al.[22], This scale contains nine items, with two possible sets of response choices: unacceptable (0), somewhat unacceptable (1), somewhat acceptable (2), acceptable (3); or extremely unlikely (0), somewhat unlikely (1), somewhat likely (2), very likely (3). Scores can range from 0-21, with higher scores indicating higher levels of SDF acceptance.

Data Analysis

Data were analyzed using IBM SPSS Statistics, version 25 [23]. Descriptive statistics were calculated to describe the sample (N=160) in terms of demographic and patient characteristics, as well as behavioral and dental visit characteristics. In order to test the reliability of the SDF feasibility questionnaire, Cronbach's alpha, α, was calculated. Cronbach's alpha is a commonly used measure of scale reliability. An appropriate α level is typically a value of .7 or higher [24]. For this study, α= .93, indicating a high level of internal consistency.

Mean levels of SDF acceptability were calculated based on scores from SDF feasibility questionnaire. SDF acceptability was dichotomized to distinguish between those with higher levels of feasibility, as compared to others via a median split (Median=1.36). Bivariate logistic regression models were constructed and analyzed to predict higher acceptability of SDF by patient demographics, and behavioral and dental visit characteristics. Significance level was set at $p < .05$ for all comparisons.

## Results

The mean level of SDF acceptance for this sample was 1.34 (SD=0.79), suggesting low to moderate levels of SDF acceptability. Demographics are displayed in Table 1 below. More than half of the patients were male (N= 99; 62%) and ranged in age from 1-10. In terms of race and ethnicity, 52% of the patients were white and 43% reported Hispanic ethnicity. More than 35% of the patients had a diagnosis of Autism Spectrum Disorder (ASD).

**Table 1:** Patient Demographics

| Variable | N | % |
|---|---|---|
| Gender | | |
| Male | 99 | 62% |
| Female | 61 | 38% |
| Autism Spectrum Disorder | 60 | 38% |
| Age Range[1] | | |
| Ages 1-6 | 51 | 32% |
| Ages 7-10 | 51 | 32% |
| Ages 11-13 | 18 | 12% |
| Ages 14-18 | 38 | 24% |
| Race[2] | | |
| White | 84 | 53% |
| African American | 51 | 32% |
| Other | 15 | 9% |
| Hispanic Ethnicity | 69 | 43% |
| Parent Education Level[3] | | |
| High School/Vocational | 47 | 29 |
| Some College | 32 | 20% |
| College/Post graduate degree | 75 | 47% |

[1]Data missing for 2 participants

[2] Data missing for 10 participants

[3]Data missing for 6 participants

Patient dental history is in Table 2 below. The majority of patients visited the dentist twice a year or more (N=109; 68%), and 51% (N=80) had a cavity filled. More than one-quarter were comfortable getting a filling (33%) and 29% were able to complete the filling despite being upset, crying, or screaming. Dental management techniques included nitrous oxide (N=27%), oral sedation (N=19%), general anesthesia (N=14%), and physical restraint (N=11%).

**Table 2**: Patient Dental History

| Variable | N | % |
|---|---|---|
| Frequency of Dental Visits | | |
| Hardly Ever/Every 2 Years | 10 | 6% |
| Once a Year | 27 | 17% |
| Twice a year or more | 109 | 68% |
| Had a Cavity Fixed | 81 | 51% |
| White Filling | 57 | 36% |
| Silver Crown | 29 | 18% |
| SDF | 3 | 2% |
| Response to Having Cavity Fixed | | |
| Comfortable with filling | 52 | 33% |
| Upset but got them done | 18 | 11% |
| Cried | 18 | 11% |
| Screamed | 11 | 7% |
| Unable to complete filling | 2 | 1% |
| Cavities untreated | 3 | 2% |
| Management techniques | | |
| Nitrous Oxide | 43 | 27 |
| Oral Sedation | 31 | 19% |
| General Anesthesia | 22 | 14% |
| Physical Restraint | 17 | 11% |

As shown in Figure 1, SDF was most acceptable for use on primary molars (30%); in particular, parents were most accepting of SDF on primary molars if the child exhibited undesirable behaviors such as kicking (31%) while having a cavity fixed (Figure 2). SDF was considered unacceptable by most parents for anterior permanent teeth. If their child needed treatment and was cooperative, parents were extremely unlikely to allow SDF treatment on anterior teeth but were somewhat likely on posterior teeth.

*Figure 1: SDF Acceptability Based on Tooth Type*

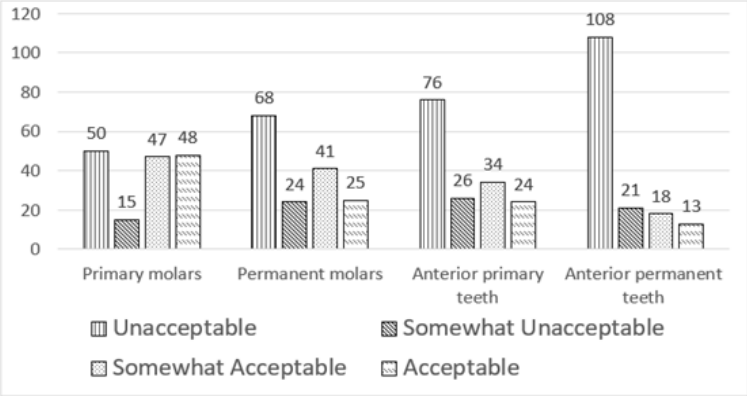
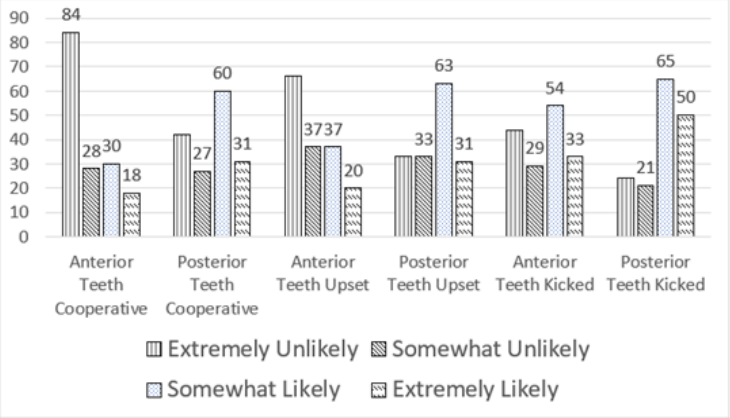
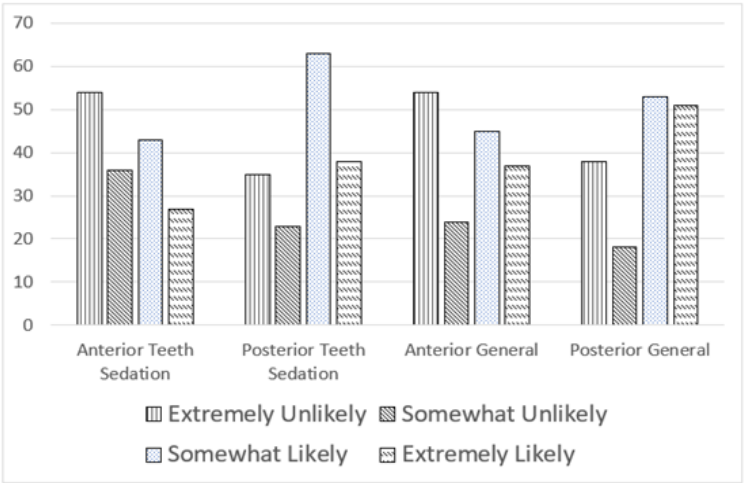



*Figure 2: SDF Acceptability Based on Behavior During Cavity Filling*




In terms of management techniques (shown in Figure 3), if their child required oral conscious sedation to complete treatment, parents were extremely unlikely to allow SDF treatment for the anterior teeth but were somewhat likely for the posterior teeth. If their child required general anesthesia to complete treatment, parents were very likely to allow SDF treatment for the posterior teeth and most were extremely unlikely to allow SDF treatment on the anterior teeth.

*Figure 3: SDF Acceptability Based on Previous Management Technique.*




Findings from the bivariate regression analysis are displayed in Table 3. Bivariate results indicate that history of oral sedation was associated with significantly higher odds of SDF acceptability (OR 2.19; [95% CI 0.97, 4.85]; P=0.05). None of the other demographic or dental history variables proved to be significant.

**Table 3**: Bivariate Logistical Regression predicting SDF Acceptance

| Variable | Odds ratio | 95% CI | p |
|---|---|---|---|
| Demographics | | | |
| White Race | 1.02 | 0.51, 2.02 | 0.96 |
| Male gender | 0.90 | 0.47, 1.70 | 0.72 |
| Autism Spectrum Disorder | 0.95 | 0.50, 1.81 | 0.87 |
| Dental History | | | |
| Visit Dentist Twice a Year | 0.77 | 0.39, 1.53 | 0.46 |
| Ever Had a Cavity | 1.44 | 0.77 , 2.71 | 0.25 |
| Cavity Fix with White Filling | 1.09 | 0.57, 2.10 | 0.80 |
| Cavity Fix with Silver Crown | 1.58 | 0.70, 3.54 | 0.27 |
| Response to Cavity Fix | | | |
| Comfortable with filling | 1.38 | 0.71, 2.69 | 0.35 |
| Upset but got them done | 1.41 | 0.53, 3.76 | 0.50 |
| Cried | 0.65 | 0.23, 1.82 | 0.41 |
| Screamed | 0.76 | 0.21, 2.70 | 0.67 |
| Management Techniques | | | |
| Nitrous Oxide | 1.42 | 0.70, 2.87 | 0.33 |
| Oral Sedation | 2.19 | 0.97, 4.85 | 0.05 |
| General Anesthesia | 2.18 | 0.87, 5.45 | 0.10 |
| Physical Restraint | 0.71 | 0.25, 2.03 | 0.53 |

## Discussion

To our knowledge, this is one of few quantitative studies examining parent attitudes towards SDF among parents of children being seen within a university clinic setting in the United States. In particular, one of the clinics was for children with special health care needs (SHCN) and therefore, 38% of the patients had a diagnosis of ASD. Children with SHCN tend to have unmet dental needs due to poor perceived behavior and a lack of trained dentists to successfully manage care for these children. Given this, it could be hypothesized that parents of children with ASD would have higher levels of SDF acceptance. Instead, our findings indicated that ASD diagnosis did not influence SDF acceptance among our sample. This is potentially because of the fact that the special needs clinic (previously described in Ocanto, et al. [25]) poses a unique situation that is not common to the general pediatric dental environment. HRSA-grant funding allows the clinic to provide free regular dental treatment and frequent desensitization visits. In addition, the pediatric dental faculty and residents are also able to provide advanced behavior mangement techniques inclusive of oral conscious sedation and treatment under general anesthesia to manage the individual needs of each child.

Similar to other previous studies, location of the tooth played an important role in SDF acceptability [20,21]. Parents of children with a past history of oral conscious sedation were significantly more likely to choose SDF as a treatment option, likely because oral conscious sedation can take multiple, time consuming appointments. For example, sedation appointments often take 2-3 hours and there is no guarantee of patient cooperation. In these cases, SDF would serve as a less time-consuming procedure with less risk.

Our clinic is located in Baudhuin Preschool, a Broward County Public School for children with ASD that is located in the Mailman Segal building at Nova Southeastern University. The preschool services students between the ages of 3 to 5 years old with disabilities determined by, meeting eligibility under the State Board Criteria. Currently the Baudhuin Preschool provides services to over 150 preschoolers with ASD through a contract with the School Board of Broward County. The service area for the school spans the majority of Broward County. Within the Mailman Segal building our one chair dental operatory servicing only the needs of the children that attend the preschool may have influenced SDF acceptability among the parents of those with SHCN surveyed in this study.

### Limitations

This study is not without limitations. This study was limited to a university clinic setting, with one of our clinics focusing on children with SHCN. This makes it difficult to generalize our results to children being seen in other settings such as a private practice. In addition, Baudhuin Preschool services children with ASD from multiple cities within Broward County that have varying SES. The area that surrounds the University where the preschool is located has a higher SES and perhaps the proximity to the dental clinic plays an important piece to who is receiving dental services. In addition, parent level of understanding of SDF was not assessed before being given the survey, however, this concern was minimized by providing the informational document and opportunity for discussion with the pediatric dental resident.

## Conclusion

Although our sample had generally low levels of SDF acceptability, some parents were likely to choose SDF as a treatment option for their child, suggesting that pediatric dentists should offer SDF as an option for treating carious lesions. Moreover, SDF may be more likely to be accepted by parents whose children have difficulty managing stress associated with conventional dental treatment.

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The authors have no conflicts of interest to report.

Author contributions

Author 1 and author 2 contributed to conception, design, data acquisition and interpretation of the study and wrote portions of the manuscript.

Author 3: Contributed to conception, design, performed all statistical analyses, drafted and critically revised the manuscript.

Author 4: Contributed to conception, design, and critically revised the manuscript.

Author 5: Contributed to conception, design, and critically revised the manuscript.

Author 6: Contributed to conception, design, and critically revised the manuscript.

Author 7: Contributed to conception, design, and critically revised the manuscript.

All authors gave their final approval and agree to be accountable for all aspects of the work.

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