Parental Expressed Concerns about Silver Diamine Fluoride (SDF) Treatment

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Background: *The staining associated with its caries arrest may be a deterrent for the use of Silver Diamine Fluoride (SDF). This study aims to elucidate the concerns that inform parents' perceptions and acceptance of SDF as a treatment option for their child.* ***Study Design:*** *We analyzed qualitative data obtained through an investigation in which parents attending a pediatric dental appointment participated in a survey, which included an open-ended question to evaluate their opinions about SDF staining. Thematic analysis of the comments, offered by the subsample of participants who replied to this question (n=43), yielded insights about perception of SDF therapy.* ***Results:*** *Most parents who provided comments were mothers (83.7%), college graduates (72.1%), primarily white (48.8%) or Hispanic (27.9%). Six themes emerged from the thematic analysis of the parents' responses: Esthetic Concerns, Psychosocial Concerns, SDF Treatment Process, Risks and Side Effects, Situational Benefits, and Dental Treatment Process. While many of the parents' comments are related to appearance, other topics that merit consideration when discussing SDF treatment were mentioned.* ***Conclusions:*** *Although parents are concerned about the esthetic impact of SDF, they understand the risks of alternative treatments and welcome information that will allow them to make an informed decision. Location of the cavities and visibility of the staining appear to heavily influence the decision to accept or reject this therapy.*

Keywords*: Silver Diamine Fluoride, Esthetics*

INTRODUCTION

Silver Diamine Fluoride (SDF) is a clear ammonia solution with silver and fluoride as active ingredients. Silver ions have antibacterial properties, and fluoride, at a concentration of 44,800 ppm, remineralizes dental tissues. SDF has been used for several decades in Asia and South America for caries arrest.

SDF 38% (Elevate Oral Care, West Palm Beach, FL, USA) was approved by the FDA in the United States for the treatment of dentinal hypersensitivity in adults. Numerous systematic reviews of clinical trials have reported its safety and efficacy for caries arrest on children [1-5]. Recently, the American Academy of Pediatric Dentistry (AAPD) published an evidence-based guideline supporting the use of SDF for the arrest of cavitated caries lesions in primary teeth, as part of a comprehensive caries management program for children[6]. It is expected that with the publication of these guidelines for treatment, the off-label use of this product will become more common, making this minimally invasive therapy more available to children who face barriers in the receipt of traditional restorative treatment[7]. SDF therapy has several benefits, including ease of application, low cost, and minimal risk. Additionally, as it does not require caries removal, there is no need for local anesthesia. The most significant drawback for its widespread use is that as caries lesions in enamel and dentin become arrested, they acquire a permanent dark staining, which can be considerably noticeable depending on the location of the cavities. (figures 1,2)

A survey of pediatric dentistry program directors[8] reported that in their perception, one of the most significant barriers to the use of SDF would be parental reluctance to accept this procedure due to its staining effect. In order to better understand parents' perceptions of the staining and the factors that impact acceptance of SDF treatment, we invited parents of children who had a history of dental caries to participate in a web-based survey. The survey was designed to identify parents' specific concerns with the esthetic effects of the material under different behavioral management scenarios. We also analyzed the demographic variables that may have had an effect on the acceptance of the treatment[9]. Our results (rounded figures)

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revealed that 68% of parents found the staining on posterior teeth to be esthetically tolerable, while only 30% said the same about anterior teeth. In a scenario where the child was cooperative enough to receive fillings, 54% of parents would choose SDF to treat posterior teeth, but only 27% for anterior teeth. Changing the scenario to one in which the child would require general anesthesia to complete regular fillings, acceptance for SDF rose to 69% for posterior teeth, and to 60% for anterior teeth. These findings support the proposition that many parents are willing to compromise esthetics to avoid more invasive and risky procedures. Our demographic analysis also showed that parents with a lower level of socioeconomic status had a generally greater acceptance of SDF staining in anterior locations, as well as in less difficult treatment scenarios. Another important finding was that when only esthetics were considered, 32-40% of parents found the treatment to be unacceptable under any circumstance (32% for posterior teeth and 40% for anterior teeth)[9].

Though the staining effect of SDF has been identified as the primary cause for parental concern, the extent, basis and implications of that concern were not analyzed. In order for clinicians to most effectively present SDF as a viable therapy for caries management, it is important to understand the specifics of potential barriers, and the basis of parents' decision-making process.

As part of the survey, an open-ended question was included to further elucidate the issues and circumstances that inform parents' assessment of SDF as a treatment option for their child. A qualitative analysis of the parents' comments has been completed. The additional insights about SDF as a treatment option that this examination has yielded are presented below.

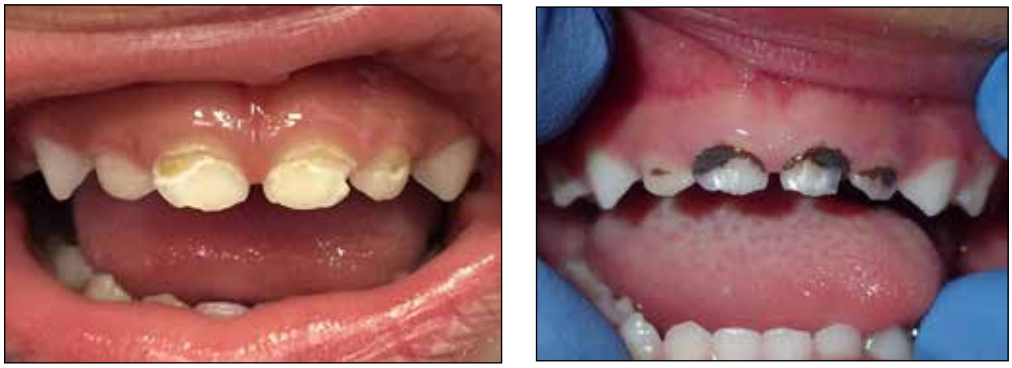
MATERIALS AND METHODS

The University Committee on Activities Involving Human Subjects at New York University (NYU) (IRBFY2016–318) approved the original study [9] . The primary goal of that investigation was to evaluate parents' acceptance of the esthetic outcomes of SDF treatment. As a continued analysis of the data collected in that study, the committee determined that the present analysis did not require an additional approval.

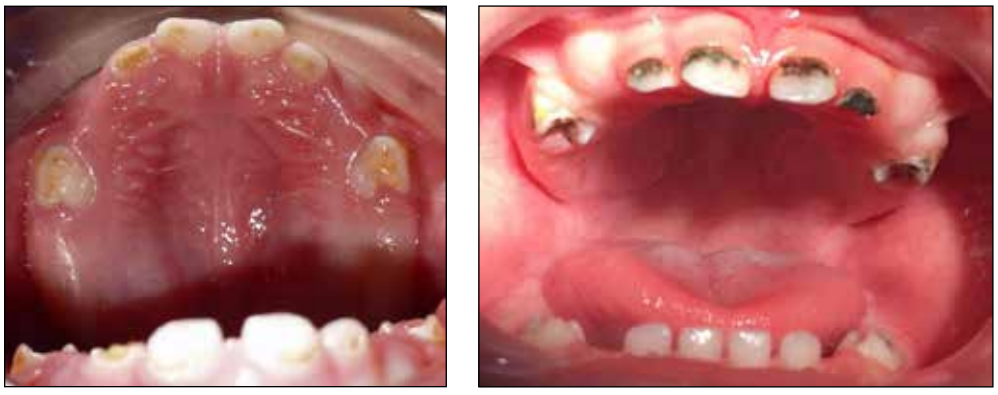
The survey study sample was recruited from dental clinics in New York and New Jersey using a uniform recruitment statement. Parents of children who had experienced dental decay were invited to complete an anonymous web-based survey (English and Spanish) on a tablet computer while waiting for their child's dental appointment. Consent was obtained in the beginning of the survey, and as participants came from diverse socio-economic backgrounds in the NYC Metropolitan area, a print version of the survey was available for those parents who preferred to complete the survey in written form.

In order to assist with their esthetic evaluation, all participants were presented with standard sets of photographs that displayed severe staining associated with SDF treatment in both anterior and posterior teeth (figures 3-4). Sets of before-and-after photos were made available with the electronic survey and as print copies[9]. Because the goal of the survey study was to assess parental opinion of the staining effects of treatment based solely on esthetics and their child's level of cooperation during dental treatment, minimal details about the treatment process were provided in the survey.

Figures 1-2: Caries lesions before and after SDF therapy



Figures 3-4: Anterior and posterior caries lesions before and after SDF therapy



To elicit additional information that would provide further understanding of parents' treatment concerns and preference, the survey included an open-ended question: "Are there any other reasons why you would or would not want your child to get this treatment?", to which the participants could enter an unrestricted comment.

Thematic analysis, a rigorous, widely used method for analysis of qualitative data[10], was used to explore, assimilate and search for the patterns or themes in the parents' responses. The analysis was conducted using an inductive approach, whereby through an iterative process of analysis[11], the themes emerged from, and were strongly linked to, the content of the parents' comments. This is an analytic approach that generates, rather than tests, hypotheses[12]. We began the thematic analysis of the data by having the three researchers (two dental clinicians and one social science qualitative researcher) each independently read all of the participants' comments to obtain a broad overview of the varied concerns and decisional processes the participants disclosed regarding SDF treatment. Next, two of the investigators worked independently to conceptually organize the data, provisionally categorizing or "coding" a comment as informing a specific subject or "theme" [10]. The third investigator then reviewed and independently evaluated both investigators' assigned groupings. Consensus on the categorization of the comments was high. The third investigator facilitated an open discussion with the other two researchers to explore and resolve minor discrepancies in their initial categorization, reaching a shared consensus on the final coding. Six major themes emerged from analysis of the content of the parents' comments to the open-ended question[11]. A descriptive title for each of the six themes, which reflected the subject content of the comments, was reached through open discussion among the three investigators.

RESULTS

Forty three (35.8%) of the 120 survey participants were motivated to include a response to the open-ended question. This subgroup of parents was similar demographically to the total survey sample[9]. As in the total survey sample, the majority of subgroup participants were mothers (83.7%) and college graduates (72.1%); primarily white (48.8%), with a proportion of Hispanics (27.9%) higher than representative of the US population (Table 1).

All parents in the study were purposely recruited because their child had previously experienced dental caries, but many parents reported that their child had also been exposed to advanced methods of behavior management during dental treatment. Among the subgroup participants, 77.8% reported that their child had nitrous oxide, 25.9% had oral sedation, 11.1% had physical restraint and 11.1% had general anesthesia (Table 2). Thematic analysis of the subgroup participants' comments to the open-ended question revealed six predominant themes: Esthetic Concerns, Psychosocial Concerns, SDF Treatment Process, Risks and Side Effects, Situational Benefits, and Dental Treatment Process. Most of the parents' comments related to esthetic and psychosocial concerns primarily addressed physical appearance. In addition, for those parents who mentioned multiple considerations, most mentioned esthetic and psychosocial concerns first, before expanding on additional issues reflected in the other four themes. This suggests that the esthetic results of SDF treatment and its ramifications might have been at the forefront of their minds. Nonetheless, the other topics that emerged as issues also merit consideration when discussing SDF treatment with parents. Details of the themes are described below, including exact quotes illustrative of typical parents' comments.

Esthetic Concerns

Parents commented that they were bothered by the effect of the process on the appearance of the tooth: "I do not like how the new treatment discolors the teeth", "Teeth get too dark in color." An additional opinion that parents frequently shared was that the staining would draw attention to the cavity: "It is visually jarring to see the darkness on the teeth when his cavities were not visible but between the teeth", "The discoloration after the liquid is applied makes the cavity look worse than how it looked from the beginning.", "Teeth look wors[e].", "It looks like their teeth are rotted." Most of the parents who commented on the staining effect had qualms specifically with the visibility of the treatment: "Discoloration on front teeth is not cosmetically pleasing.", "I would not like my child to have cavity treatment to her front teeth." Some of these parents do express situational benefits of the treatment for back teeth.

Table 1: Sociodemographics of the Qualitative Subgroup and Total Survey Sample

	Qualitative Subgroup (n=43)		Total Survey Sample (n=120)	
	%	n	%	n
Parental Status				
Mother	83.7%	36	81.7%	98
Father	16.3%	7	18.3%	22
Race/EthnicityΨ				
White/Caucasian	48.8%	22	42.5%	51
Hispanic/Latino	27.9%	12	36.7%	44
Black/African American	16.3%	7	11.7%	14
Asian/Pacific Islander	2.3%	1	10.0%	10
Not answered	4.7%	1	3.3%	4
Educational Level				
High School or less	23.3%	7	25.0%	30
Some College	9.3%	5	15.0%	18
College Graduate	72.1%	31	59.2%	71
Not answered	0%	0	0.01%	1
Insurance Type				
Private	60.5%	26	48.3%	58
Medicaid	30.2%	13	42.5%	51
None	4.7%	2	5.0%	6
Other	4.7%	2	4.2%	5

n = number of respondents for that question

Ψ = number of responses is greater than the total number of respondents for the total survey sample

Table 2: Qualitative Subgroup and Total Survey Sample Reports of Child's Behavior During Previous Dental Fillings and Need for Advanced Behavior Management Methods for the Completion of Dental Treatment

	Qualitative Subgroup (n = 43)		Total Survey Sample (n = 117)	
	%	n	%	n
Child's Response to Getting Dental Fillings[Ω]				
was fine to do the fillings	62.8%	27	54.7%	64
was upset but the fillings got done	30.2%	13	30.77%	36
cried	16.3%	7	18.80%	22
kicked	4.7%	2	4.27%	5
screamed	7.0%	3	5.98%	7
was unable to get the fillings done	0%	0	2.56%	3
did not get the cavities treated	4.7%	2	4.27%	5
	Qualitative Subgroup (n = 27)		**Total Survey Sample (n = 75)**	
	%	n	%	n
Advanced Behavior Management Methods[Ω]				
nitrous oxide (laughing gas)	77.8%	21	64%	48
oral sedation (medicine to make them tired)	25.9%	7	24%	18
physical restraint (had to be held down)	11.1%	3	17.33%	13
general anesthesia (put to sleep in the hospital)	11.1%	3	13.33%	10

n = number of respondents for that question

Ω = number of responses is greater than the total number of respondents for the qualitative subgroup and the total survey sample

Psychosocial Concerns

The psychosocial concerns that parents expressed reflected a belief that the esthetic impact of the SDF treatment would result in damaging psychosocial effects to their child due to how the staining would alter their appearance: "The appearance would be somewhat embarrassing", "A person's oral presentation speaks for them within the first impressions that they make". Other parents' statements reflected their trepidation about how others would behave towards their child following the adverse cosmetic impact on their child's appearance: "Discoloration on front teeth can cause issues in young children who may be made fun of by other children.", "Even though it stops the cavity, I wouldn't want it to be noticeable to others. Kids are cruel and would tease others for having black teeth."

SDF Treatment Process

Parents raised a number of questions about the SDF treatment process that they wanted answers to when considering this procedure as an option for their child: "Several factors–location and severity of cavity. I would want to know the success rate of the product. How long it lasts, how much it would cost. If it had to be re-applied.. is it a delay until the child can cope better for eventual traditional repair." Others mentioned the need for more information in general about this treatment to make an informed decision: "More information will be needed so that I would have a better understanding."

Risks and Side Effects

Connected to the treatment process, a number of the parents' comments related explicitly to the issue of potential side-effects and health risks from the procedure: "Concern about health risks of product painted on teeth", "Can it cause problems for the health of the tooth in future?", "How would that effect new teeth?" Simply summarized, parents noted the importance of being fully informed about the treatment: "Pros and cons of treatment [besides the color]".

Situational Benefits

Although most of the parents' comments focused on esthetic and psychosocial concerns associated with SDF treatment, a number of statements did inform the circumstances in which parents would consider this treatment option for their child. Location of the cavity was a primary consideration in a number of their statements: "I would be very likely to have the treatment done on the back teeth.", "Depends on if it is horribly visible. Otherwise, less invasive treatment, the better." Other elements that parents addressed when considering this treatment were: "The severity [of the cavity], and my child's willingness.", "[I] think this product is a great idea for all children who are scared of the dentist. I also think this product can work for building a strong relationship with the dentists for future visit's."

Dental Treatment Process

Parents' treatment decision-making considerations are informed by their child's overall oral health history and prior dental experiences. Several of the parents' comments related distressing occurrences with advanced behavior management techniques utilized during a dental procedure. Under such circumstances they expressed willingness to learn about other options and new developments: "I would not want them to have to have anesthesia or to be restrained again." Another consideration parents weigh is the time involved in receiving care: "I would prefer to do the fillings the first time instead of a temporary fix. I do not have time to keep going back to the dentist since I work full time and have three children."

DISCUSSION

The comments offered by parents who participated in this survey reveal a great deal about how the staining effects of SDF might affect its reception as a treatment option. Using thematic analysis as a method for identifying, analyzing, organizing, describing, and reporting themes found within our data, this study provides unique insight about the reception of SDF treatment, as it compiles and analyzes the open-ended comments of parents. Qualitative research, such as the analysis reported here, is a valuable inquiry process that can be used to inform patients' concerns, goals and preferences for dental care[13], but it is a methodology that is underutilized in clinical care.

The parent sample in this analysis is a situational representation, not different from the subgroup of parents who will have many questions and reservations about treatment recommendations for

their children in any clinical setting. Their comments inform our understanding of clinical treatment decision-making, specifically the factors that parents weigh when considering the benefits and consequences of a non-routine dental treatment. The analysis expands our understanding of the range of insights, experiences, circumstances and preferences, when options are available, that may guide the clinical decision-making process of parents in similar situations.

Many clinicians base their treatment decisions on the reported success of specific restorative techniques alone. Patient-centered outcomes, which have more to do with what the children and their parents, as a unit, consider to be a successful treatment, are far more important in the delivery of care. We believe that focusing on patient-centered outcomes can have a greater impact in achieving health, (oral and overall health) over a long period of time[14]. With this said, taking into consideration parental concerns and needs in our case selection, presentation and implementation of treatment will aid in achieving a unified patient/family/clinician goal of overall sustained health status for the patient into the future.

The majority of the comments offered by parents in this investigation addressed discontent with the staining effect associated with SDF treatment. Parents expressed particular concern with discoloration of the front teeth. Research has shown that both dental and lay individuals can distinguish between even subtle esthetic differences in dental appearance [15]. More importantly, laypersons have shown to be more critical of dental-facial esthetics than dental professionals and more sensitive to minor cosmetic differences such as darker colored incisors and enamel defects caused by fluorosis [16, 17]. Parents specifically have expressed major concerns regarding the color of their children's teeth[16] and have been shown to favor treatment for darkly colored incisors much more frequently than dentists[18]. Parents have been found to have an increased sensitivity to esthetic changes in their children's teeth when the child grew closer to adolescence and express more concern about their children's permanent dentition over their primary/mixed dentition[19]. In addition to their parents, school-aged children have also shown to have concerns with color changes in front teeth[19]. Shulman found that children were more critical of the color of their teeth than either their parents or dentists.[17]

Though some parents expressed personal concern simply with the dark colored staining that results from SDF treatment, many explicated an apprehension that went beyond esthetics. Most parents believed that the esthetic result of this treatment would result in damaging psychosocial effects to their child due to the judgments and associated behavioral responses of other individuals. Woo noted that adults and children have both been recognized to make judgments about other children based solely on physical attractiveness [18]. More specifically, children have an awareness of their own dental esthetics as well as those of other children [20]. Children as young as three years old have been recognized to have an understanding of dental esthetics including absent or darkened teeth [21]. Though children and adolescents are capable of evaluating dental esthetic appearance, both are still likely to be influenced by their parents' opinions[19].

In light of these reported issues, in our esthetics-driven society, clinicians have to make sure that parents understand the benefits of SDF therapy, compared with other treatment options. Conventional restorative treatment does not address the underlying causes of the caries process[22], so re-incidence rates of caries are as high as 40% a year after treatment[23] in high risk children. In contrast, arrest rates with biannual application of 38% SDF over a period of 18 months, cited at 82% for maxillary anterior teeth, 60.5% for mandibular posterior teeth and 58% for maxillary posterior teeth[5] and at 82% overall[1], are relatively high. SDF therapy, with its antibacterial effects, effectively stops caries progression and reduces sensitivity, which allows parents and children to establish home care routines that are essential to lowering overall caries risk [24]. The prospect of benefiting from a non-invasive chemotherapeutic management procedure for dental caries should put into perspective the problem of staining. Parents should also be made aware that once active caries lesions are controlled, this therapy can be followed by more esthetic options as the child is able to cope with involved restorative treatment[6]. The concern of food retention in hard-to-clean cavities can also be addressed by placing restorations on those teeth at a later date.

In regard to the potential health risks associated with SDF treatment, the danger of fluoride toxicity of this product is minimal when following the manufacturer's instructions, as it contains less fluoride than that present in currently recommended doses of fluoride varnish (the current standard of care for caries prevention)[25]. And although the long-term effects of repeated low exposure to silver ions is relatively unknown, the safety of SDF used for caries arrest on primary teeth has been corroborated by studies encompassing over 4000 school age children worldwide who reported no serious side effects as a result of the treatment[7]. However, the long-term effect of these and other minor and infrequent side effects, such as gingival irritation, merit further investigation[26]. At any rate, these risks are minimal when compared to those associated with advanced behavior management techniques such as sedation and general anesthesia [27]. Recent studies have found that parental acceptance of behavior management techniques has changed over the years, with increasing approval of pharmacological management and decreasing approval of physical management [28]. Concern regarding physical restraint was obvious in some of the comments, and it was clear that parents would favor less invasive and risky methods of dealing with cavitated lesions, when such an option is available.

It is apparent from this analysis that a dialog with parents, addressing all areas of individual concern, is imperative for adequate case selection when considering SDF therapy. Indeed, as revealed in the thematic analysis, many of the parents' comments reflect a general lack of understanding of the SDF treatment process and of the many elements to consider when developing the best treatment plan for the child. These findings elucidate the importance of parental education by the dental clinician. Consideration of the child's age, social awareness and behavior, extent of the disease, location of the cavities, individual risk factors, as well as parental esthetic concerns, are essential to achieve patient-centered outcomes. Parental understanding of the advantages of this therapy compared to other options is as important as understanding the consequences of no treatment, and the importance of making a timely decision to avoid more involved treatment and behavior management options [29, 30].

Limitations

Although we had diverse sociodemographic representation in our study sample, it is important to note that the survey sample was limited to a specific geographic area (New York and New Jersey).

It should also be mentioned that the investigation elicited opinions from parents whose comments on the staining results of SDF were based on photographs, admittedly, an approach which would be consistent with information on an informed consent. Furthermore, although open-ended questions provide an opportunity for greater understanding and more useful information about parents' attitudes about the value and detriments of SDF treatment than closed-ended items alone[31], our findings are limited to comments that reflect the viewpoints of those parents who chose to provide supplemental observations. We also acknowledge that even though the open-ended question did yield additional insights, the data collection format—self-administered, anonymous surveys, did not provide an opportunity for probing and follow-up questions, as would have been possible with an interviewer-administered survey[11]. Our investigation explored the parental attitudes and concerns about a potential future SDF treatment, future studies should further explore parental experience and concerns after SDF application on their children.

CONCLUSIONS

Parents have clear concerns with the impact of the esthetic compromise of SDF therapy on their children, but understand the risks of alternative treatments and would welcome information that will allow them to make an informed decision. Location of the cavities and visibility of the staining seem to be major considerations when deciding whether to accept this therapy. Inclusion of all pertinent information of the advantages and drawbacks of this therapy in a thorough informed consent and taking into consideration the patient's needs, risks and individual circumstances during case presentation are important to achieve patient-centered health outcomes.

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