

RESEARCH

Perceptions of Registered Dental Hygienists in Alternative Practice Regarding Silver Diamine Fluoride

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Abstract

Purpose: Silver diamine fluoride (SDF) is an inexpensive, non-invasive, antimicrobial liquid used to treat carious lesions and decrease sensitivity. The purpose of this study was to assess the perceptions of registered dental hygienists in alternative practice (RDHAP) regarding the use of SDF to treat dental caries.

Methods: A 16-item survey designed to evaluate RDHAP's familiarity and perceptions of SDF was electronically distributed to 222 RDHAPs practicing in the state of California. A survey research software program collected and tabulated responses, calculated response frequencies for each survey item, and determined statistical relationships among variables, using cross tabulation analysis.

Results: The response rate was 46% (n=103). Over half the respondents, 54%, were unfamiliar with SDF. After describing SDF's properties and uses, 78% of respondents agreed that applying SDF to treat dental caries would be within the scope of practice of a RDHAP. Respondents agreed that patients or parents of patients would be interested in using SDF because it provides an alternative to removing tooth structure with a dental drill in order to place restorative material (82%), less expensive than restorative treatment (82%), applied like a varnish and time efficient (86%), and utilized without local anesthesia (91%). Over 56% of the respondents agreed that many patients or guardians of patients would object to the permanent black staining of the carious lesion treated with SDF. The respondents' employment/practice settings were related statistically ($p < 0.01$) to their agreement that SDF is within the RDHAP scope of practice and their disagreement the question that patients would not accept SDF treatment due to the black staining ($p = 0.03$). Eighty-eight percent of the respondents felt that the advantages of SDF outweigh the disadvantages for their patient populations.

Conclusions: SDF would be a useful therapeutic agent for the treatment of dental caries for RDHAP practitioners treating underserved populations.

Keywords: alternative practice, registered dental hygienist in alternative practice, dental caries, silver diamine fluoride, preventive products, special needs patients

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Introduction

The traditional method of treating dental decay in the United States (U.S.) has been restorative dental treatment, which can be expensive, time consuming, and difficult to access for many patient populations.¹⁻⁴ Silver diamine fluoride (SDF) is an inexpensive, non-invasive, antimicrobial liquid used in several countries to treat carious lesions and decrease sensitivity.¹ As of April 2014, a 38% SDF was cleared for marketing as a Class II medical device by the U.S. Food and Drug Administration (FDA) for the treatment of dentinal hypersensitivity.^{1,5} Marketed as Advantage Arrest™ (Elevate Oral Care LLC, West Palm Beach, FL), SDF has been used in the U.S. (off-label), for the arrest of carious lesions.^{1,4,5} In October of 2016, the FDA granted the designation

of breakthrough therapy to Advantage Arrest 38% SDF as a treatment for arresting dental caries in children and adults.⁶ This designation is designed to expedite the development and review of drugs that address a serious medical need and is based on preliminary clinical evidence indicating that the drug may demonstrate significant improvement over current therapies.

Previous studies on SDF have focused primarily on its clinical efficacy.^{2,7-10} Using SDF at 38% concentration has been highly effective in the arrest and prevention of carious lesions.¹⁻¹² SDF contains silver ions that act as antimicrobial and bactericidal agents within lesions by destroying bacterial membranes, denaturing proteins, and inhibiting DNA replication.^{1,13} The fluoride ions in SDF help create

fluorapatite, a more acid-resistant enamel which can prevent further demineralization of tooth structure.¹⁴ Applying SDF to occlusal, facial, and lingual surfaces has been shown to be successful in arresting caries in multiple clinical trials,^{1,2,7-10} and its application to interproximal surfaces is currently being studied.^{1,8} While a single application of SDF appears insufficient for sustained effects, annual and semi-annual re-applications have been shown to be highly successful.¹ Furthermore, SDF application is cost effective; one 8mL bottle of Advantage Arrest™, costing approximately \$129, is sufficient to treat 1,600 carious lesions. The widespread use of SDF is limited by the fact that it stains the carious lesion black, and sometimes causes a temporary metallic taste.^{1,2,7-12,15-17} Acceptability of the black staining has been studied in two recent studies.^{2,18} Chu et al. demonstrated that parents of Chinese preschool children expressed no significant changes in their satisfaction with their child's appearance following treatment with SDF.² In an initial report of parental response to a scenario of a large cavity on their child's baby molar, parents' decisions regarding SDF treatment were influenced by their child's behavior and gender, the location of the tooth to be treated, and the use of local anesthesia.¹⁸ SDF treatment can be a promising strategy to manage dental caries in young children and those who have special needs.² Geriatric patients with high anxiety or special needs and other patient populations could also benefit significantly from its application.^{4,19-22}

The incidence of oral disease is disproportionately greater for lower-income and rural populations, racial and ethnic minorities, medically compromised or disabled populations and young children.²³ In California, the licensure category of registered dental hygienists in alternative practice (RDHAPs) was created to help care for the substantial percentage of the population lacking access to dental care.^{23,24} RDHAPs receive specialized training and a specific license to treat patients with limited access by delivering dental hygiene care in the residences of patients that are homebound, at schools, residential facilities, community institutions, and other dental health professional shortage areas.²² RDHAPs are most likely to use SDF as they are authorized to provide preventive oral health services without direct supervision in these community-based settings.^{23,25}

Although the clinical efficacy of SDF has been extensively studied,¹⁷ SDF is relatively new to the field of dentistry in the U.S. Consequently, the level of knowledge possessed by RDHAPs in California regarding SDF treatments is not known. The purpose of this study was to assess the perceptions of RDHAPs regarding the use of SDF to treat dental caries.

Methods and Materials

This cross-sectional study was approved by the Institutional Review Board of the University

of California, San Francisco (UCSF). The target population consisted of dental hygienists licensed as RDHAPs in the state of California. RDHAP email addresses were acquired from various Internet sources, i.e., publically available lists available from the Dental Hygiene Committee of California (DHCC), California Dental Hygienists' Association (CDHA), and LinkedIn. All RDHAPs with known email addresses were included in the invitation to participate in the electronic survey.

A 16-item survey instrument was created to assess the perceptions of RDHAPs regarding treatment of caries with SDF. To assess the respondent's familiarity with SDF, 8 response options were offered ranging from "never heard of product" to "use product frequently." A brief description of SDF's characteristics followed this item, for the benefit of respondents not familiar with SDF: SDF is an inexpensive, non-invasive clear antimicrobial varnish that can be applied with a micro-brush; SDF contains a fluoride concentration of 5%, which is twice the amount of fluoride present in 5% sodium fluoride varnish (2.26%); and the area treated with SDF hardens and turns black. The 12 subsequent questions, regarding the respondents' perceptions, used the 5-point Likert scale, ranging from strongly agree to strongly disagree. The survey was created and distributed using Qualtrics™ (Provo, UT), a survey research program.

The survey was pre-tested on a convenience sample consisting of 8 dental hygienists in the Master of Science in Dental Hygiene program at UCSF, 2 dentists currently studying SDF at UCSF, and 2 practicing RDHAPs, in order to assess survey acceptability and feasibility. Survey modifications were made based on feedback.

A request to participate in the survey was distributed electronically to the respondents describing the purpose of the study, in addition to providing instructions for giving informed consent and a link to the survey instrument. Accessing the survey indicated the participant's consent. Follow-up email messages were sent to non-respondents at 3, 6 and 8 weeks following the initial distribution to encourage participation.

Qualtrics™ tabulated the responses and calculated the response frequency for each survey item. Cross tabulation analysis determined the significant relationships between respondents' employment/practice settings and their responses regarding perceptions of SDF, as well as between respondents' responses regarding their perceptions.

Results

Respondent's demographic information and level of familiarity with SDF

Of the 222 potential respondents, 103 completed the online survey (n=103), resulting in a response rate of 46%. One hundred and nineteen respondents

stated that they worked in private practice and/or a community or public health clinical care settings (Table I). Ninety-two percent of the respondents had received their RDHAP licensure between 2003 and 2013 "or later." The time frames that the RDHAPs received their licences were similarly distributed over the ranges of years that were delineated in the survey, 2003-2007 (31%), 2008-2012 (32%), and 2013 "or later" (29%) as shown in Table II. Fifty-four percent of the respondents were unfamiliar with SDF as a caries therapeutic agent with 32% reporting that they had never heard of SDF and 22% stating that they were not sure what the SDF product was used for. (Table III)

Respondents' perceptions regarding SDF as a caries therapeutic agent

Seventy-eight percent of the respondents agreed that the application of SDF was within the RDHAP scope of practice. (Table IV) Respondents' agreement that the use of SDF was within the RDHAP scope of practice was statistically related to their type of employment/practice setting ($p < 0.01$). Almost all respondents agreed that SDF treatment could enhance the oral health of patients in RDHAP specialty areas and patient groups in low-income communities, challenging pediatric patients, geriatric patients, and those with high anxiety or other special needs.

The majority of respondents agreed that many patients or their parents would be interested in SDF for the reasons expressed in the survey displayed in Table V. Ninety-one percent of the respondents agreed with the statement, "Patients (or the parents of patients) would be interested in SDF because it does not require the use of local anesthesia." A small number of respondents disagreed with statements describing the advantages of SDF. Fifty-six percent of the respondents agreed that many patients or their parents would not accept treatment of dental caries with SDF due to the permanent black staining of the carious lesion. This perception was significantly related ($p = 0.03$) to their employment/practice settings. (Table V)

Overall, 88% of respondents perceived that the advantages of SDF outweighed the disadvantages for the patients that they were accustomed to treating in their RDHAP practice settings. The statistical relationship of this statement to other responses is summarized in Table VI. Most respondents agreed that they "would like to use SDF to arrest active carious lesions" in their patients

Table I. Current setting of employment/practice of respondents, by percentage and number of respondents

Current setting of employment/practice* (N=87)	Respondents % (n)
Clinic care:	
Private practice	58 (49)
Community or public health	82 (70)
Education:	
Oral health for school children	14 (12)
Dental professional education program	21 (18)
Administration:	
Educational institution	4 (3)
Public health organization	2 (2)
Government organization	0
Non-Profit organization	2 (2)
Not practicing	2 (2)
None of the above	1 (1)

*Participants selected as many as applied

Table II. Professional background of respondents, by percentage and number of respondents

Professional background	Respondents % (n)
Year of RDHAP licensure (N=87)	
1998-2002	8 (7)
2003-2007	31 (27)
2008-2012	32 (28)
2013 or later	29 (25)
Years of practice as an RDHAP (N=86)	
Less than 1	12 (10)
1-3	27 (23)
4-6	21 (18)
7-10	26 (22)
Over 10	15 (13)

Percentages may not equal 100% due to rounding

(91%) and that they "want to offer the option of SDF so that [their] patients receive the best dental care" (93%).

Discussion

This study assessed the perceptions of RDHAPs regarding the use of SDF to treat dental caries. Treating carious lesions with SDF is especially useful in situations where dental resources are limited and treatment can be carried out by dental auxiliaries;²⁶ situations in which RDHAPs typically practice. The majority of respondents agreed that the application of SDF to treat dental caries is within the RDHAP's

scope of practice. These respondents are in agreement with the California law allowing RDHAPs to apply topical therapeutic agents for the control of dental caries without direct supervision.^{25,27} The phrase, "without direct supervision," allows for RDHAPs to practice in specified settings including the residences of the homebound, nursing homes, hospitals, residential care facilities, dental health professional shortage areas, and other public health settings.^{23,25}

Table III. RDHAP familiarity with SDF, by percentage and number of respondents

Familiarity (N=100)	Respondents % (n)
Never heard of SDF	32 (32)
Heard of SDF but not sure what it is used for	22 (22)
Aware of what SDF is used for	43 (43)
Observed SDF being used	1 (1)
Used SDF once	0
Used SDF a few times	0
Use SDF occasionally	1 (1)
Use SDF frequently	1 (1)

Percentage may not equal 100% due to rounding

Table IV. Perceptions of respondents regarding the use of SDF within the RDHAP scope of practice, by percentage and number of respondents

Survey items	Respondents' level of agreement % (n)				
	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
The application of SDF is within the RDHAP scope of practice (N=89)	52 (46)	26 (23)	19 (17)	3(3)	0
SDF treatment could enhance the oral health of my patients in RDHAP specialty areas (N=89)	80 (71)	16 (14)	4 (4)	0	0
SDF treatment could enhance the oral health of patient groups including: low income communities, challenging pediatric patients, geriatric patients and patients with high anxiety or other special needs (N=87)	76 (66)	20 (17)	5 (4)	0	0

Percentage may not equal 100% due to rounding

Most of the respondents, who agreed that "the application of SDF is within the RDHAP scope of practice", also reported that they were currently practicing in community or public health settings. These respondents most likely viewed their scope of practice in terms of the activities and needs required by the patients in the settings in which they practice. Practicing in community/public health settings may have provided these respondents experiences that enhanced their comfort working in an environment with limited resources and supervision while serving patients with extensive dental needs. Because the RDHAP may be the only oral health care provider these patients see,^{23,26} the RDHAP may be more accustomed to the greater demands and expectations of extended dental services.

Approximately one quarter of the respondents did not believe that the application of SDF to treat dental caries was within the RDHAP scope of practice. These respondents may have disagreed based on the survey's use of the phrase "to treat dental caries." They may have viewed the treatment of dental caries as the sole responsibility of the designated supervising dentist. Also, many dental hygienists including RDHAPs may see their role as preventive rather than treatment-based. In addition, the description of SDF's application technique, "can be applied with a micro-brush", may have required additional clarification, for example, that the excavation of soft dentin is not needed because SDF will react with the tooth surface and create a layer of silver protein that resists bacterial acids and promotes the formation of hydroxyapatite and fluorapatite.^{15,17} Some

respondents raised concerns about the legal ambiguity regarding the use of SDF “off-label” to treat dental caries. They may not have been aware that off-label use of approved pharmaceuticals is common, and these drugs frequently have medical evidence supporting their “off label” use.²⁸ As a Class II medical device, regulatory controls are required to provide assurance of the device’s safety and effectiveness.²⁸ Similar to SDF, sodium fluoride varnish has been cleared by the FDA for treatment of dentinal hypersensitivity,²⁹ although it is widely used to prevent dental caries.¹⁶ Since the time this survey was conducted in 2015, SDF has been granted the designation of Breakthrough Therapy as a treatment for arresting dental caries in children and adults by the FDA.⁶

The majority of respondents agreed that patients or their parents would be interested in SDF for a number of reasons. First, it is an alternative to removing tooth structure by drilling to place

restorative material. Avoiding dental procedures involving use of a drill could substantially alleviate the angst associated with a dental visit for many patients. Secondly, SDF is applied like a varnish on top of the carious lesion, thus, it does not require the use of local anesthesia. Fear and stress frequently prevents people from visiting the dentist and is attributed to a variety of factors, including the sound of the dentist’s drill and the thought of the needle to administer local anesthesia.^{30,31} The greatest percentage of respondents strongly agreed that fear of the injection for local anesthesia is a major contributor to dental anxiety. Furthermore, the application procedure of SDF, like that of other topical agents and varnishes, considerably reduces the amount of time required for a dental visit to treat caries.^{19,20} Lastly, the potential cost of a dental visit can create a barrier for the patient to avoid dental appointments and treatment;³¹ however in contrast,

Table V. Perceptions of respondents regarding the advantages and disadvantages of SDF, by percentage and number of respondents (N=89)

Survey items	Respondents’ level of agreement % (n)				
	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Advantages Many patients (or parents of patients) would be interested in SDF because:					
It is an alternative to removing tooth structure by a dental drill in order to place restorative material	46 (41)	36 (32)	12 (11)	6 (5)	0
It is less expensive than restorative treatment	57 (51)	25 (22)	15 (13)	3 (3)	0
It is applied like a varnish and therefore time efficient	60 (53)	26 (23)	12 (11)	2 (2)	0
It does not require the use of local anesthesia	70 (62)	21 (19)	8 (7)	1 (1)	0
Disadvantages					
Many patients (or parents of patients) would not accept treatment of dental caries with SDF due to the permanent black staining of the carious lesion	12 (11)	44 (39)	27 (24)	16 (14)	1 (1)
Clinicians would not want to use SDF because of the potential permanent staining to clothes and counter tops/ floors if spilled	4 (4)	9 (8)	30 (27)	43 (38)	13 (12)
The advantages of SDF outweigh the disadvantages to the patients I am accustomed to treating as an RDHAP					
	70 (62)	18 (16)	11 (10)	1 (1)	0

Percentage may not equal 100% due to rounding

Table VI. Relationships between the responses to the survey item “advantages of SDF outweigh the disadvantages” and responses to other survey items:

Survey Items	P Value
Many patients (or parents of patients) would be interested in SDF because:	
• It is an alternative to removing tooth structure by a dental drill in order to place restorative material	<0.01
• It is less expensive than restorative treatment	<0.01
• It is applied like a varnish and therefore time efficient	<0.01
• It does not require the use of local anesthesia	<0.01
I want to offer the option of SDF so that my patients receive the best dental care	<0.01

SDF is very cost effective. Currently sold for approximately \$129.00 per bottle (8mL), one drop of SDF (25µL) is sufficient to treat five teeth.¹ Therefore SDF may be a viable option for patients faced with the problem of limited financial resources.^{10,21}

Over half of the respondents agreed that many patients would not accept the treatment of dental caries with SDF due to the permanent black staining of the carious lesion. This may be an assumption by respondents who feel that patients are biased by the media, marketing the importance of esthetic appearance. However, based the studies of Chu, et al. and Tesoriero, et al., this may not be true, especially in all cultures. In Chu’s study parents of Chinese preschool children expressed no change in satisfaction with their children’s teeth and appearance following SDF treatment.² While these results from a Chinese culture may not be directly related to Western norms, Tesoriero’s study was conducted in New York where most of the parents were comfortable with SDF treatment on a posterior tooth but not on an anterior tooth.¹⁸

The greatest number of “disagree” responses to the statement, “Many patients (or parents of patients) would not accept treatment of dental caries with SDF due to the permanent black staining of the carious lesion” were from respondents who were currently practicing in community or public health settings. This may be because the RDHAPs working in these settings may be regularly treating patients whose primary concern is having teeth free of painful carious lesions. Teeth with black stains due to SDF may not be a contraindication for them.

The majority of respondents agreed that the advantages of SDF, including its low cost, efficiency of treatment, and the fact that it does not require the use of local anesthesia, outweighed the disadvantage of the black staining for their patient populations. Moreover, the nature of the application procedure facilitates its use by dental auxiliaries, such as RDHAPs.²⁶ Consequently, the respondents in this study would like to use SDF to arrest active carious lesions in their patients and to offer the option of SDF so that their patients can receive optimal dental care.

The finding that approximately half of the respondents were unfamiliar with SDF as a caries therapeutic agent was not surprising

since SDF was not available in the United States until 2015.¹ However, due to SDF’s substantial benefits, the issue of lack of knowledge should be addressed. Opportunities need to be promoted to educate all oral health care providers of the advantages/disadvantages of the application of this medicament. It is recommended that dental hygiene educational programs at all levels—entry-level to advanced degree—provide both didactic information and clinical experiences. More continuing education programs with similar didactic and clinical components are also recommended. Education should not be limited to oral health care providers, but include other health care providers, especially pediatricians and nurses.

One limitation in generalizing these results to a broader population is that the subjects of this study were RDHAPs. This category of dental hygienist is somewhat unique to California, although many other states allow dental hygienists to practice in specific settings with less supervision.³² Furthermore the 46% response rate may suggest a response bias. RDHAPs who were not familiar with SDF may not have been interested in completing the survey. Ten of the 11 respondents, who did not continue the survey after the item probing familiarity, indicated that they were not familiar with SDF. Another limitation may be the use of the term, “private practice,” which may have been ambiguous in terms of their current setting of employment/practice. Respondents owning RDHAP practices may consider “RDHAP private practice” as referring to something other than what is commonly known as a “private practice” in the field of dentistry. It might have been prudent to define private practice as being associated with a supervising dentist, a requirement for RDHAPs in California. The option to type in an answer allowed for clarification of respondents’ interpretations.

Conclusion:

The clinical application of SDF has been shown to be effective in arresting carious lesions, however its use depends upon the oral health care providers’ familiarity with the product and their perceptions of its benefits

to their patient population. This study surveyed RDHAPs, dental hygienists who are licensed to treat underserved patients in a variety of settings in California. Approximately half of the respondents were unfamiliar with SDF, which emphasizes the need for the properties of SDF to be addressed in dental hygiene educational programs and continuing education courses. After being informed of the application process and SDF's clinical efficacy, most respondents agreed that the use of SDF was within their scope of practice. These respondents felt that their patients or the parents of their patients would be interested in this treatment due to its advantages, including not requiring local anesthesia and the removal of tooth structure, its low cost and reduced treatment time. According to the respondents, these advantages outweighed the disadvantage of permanent black staining of the carious lesion, and they were interested in offering the option of SDF as a means of delivering optimal dental care.

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