CROSS-SECTIONAL STUDY

Silver Diamine Fluoride in Pediatric Dentistry Training Programs: Survey of Graduate Program Directors

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Abstract: ***Purpose:*** *The purpose of this study was to investigate practice, teaching, and perceived barriers to the use of silver diamine fluoride and other caries control agents in U.S. pediatric dentistry residency programs.* ***Methods:*** *A 14-question survey regarding use and teaching of caries control agents was sent via email to residency program directors in 2015. Survey participants responded, using a web-based survey tool, by completing a paper and pencil survey instrument, or by interview.* ***Results:*** *Surveys were completed by 74 directors or associate directors (87 percent adjusted response rate). More than a quarter (25.7 percent) reported use of silver diamine fluoride, with 68.9 percent expecting to increase use. The use of silver diamine fluoride was not associated with region or program type. Programs reported commonly used caries control agents of fluoride varnish (100 percent), acidulated phosphate fluoride foam (48.6 percent), silver nitrate (9.5 percent), and povidone iodine (1.3 percent). Most felt silver diamine fluoride should be used only with high-risk patients (89.2 percent), and the majority agreed it could be used in primary and permanent teeth. The most frequently reported barrier to use of silver diamine fluoride was parental acceptance (91.8 percent).* ***Conclusions:*** *Silver diamine fluoride is being rapidly adopted in graduate pediatric dentistry training programs, with the majority expecting to incorporate it into their teaching clinics and curricula.* *(Pediatr Dent 2016;38(3):212-7) Received February 16, 2016 / Last Revision March 27, 2016 Accepted March 28, 2016*

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Curriculum standards for Advanced Specialty Education Programs in Pediatric Dentistry are set by the Commission on Dental Accreditation.[1] The standards call for programs to prepare residents beyond the level of general dentists. As a result, curriculum decisions in these specialty programs represent the leading edge of dental education and may be an indication of changes to come in undergraduate dental education and dental hygiene curricula more generally.

In a 2009 position paper by Casamassimo et al., wide variations in teaching practices were found across pediatric dentistry residency programs. The authors recommended increased standardization of didactic and clinical education to better meet the needs of the public.[2] In terms of dental caries management curriculum, Ramos et al. suggested teaching residents contemporary disease management protocols by combining new didactics and applied learning in community-based settings.[3] Surprisingly, among papers on changes in preventive care for children, there is no meaningful discussion of curriculum changes in pediatric dental residency training.[3-7]

Aqueous silver diamine fluoride ($[Ag(NH_3)]_2F$); **SDF**) has been used for decades by dentists in Japan and other countries to arrest dental caries.[8-13] Until recently it has not been used in the United States, although some have reported applying silver nitrate (**$AgNO_3$**) followed by fluoride varnish.[14] SDF is low cost and easy to apply and has been shown to be effective for caries arrest and prevention in international studies.[15] When decayed teeth are treated with SDF, a precipitate of Ag_3PO_4 forms an insoluble layer on the softened dentin. The exact mechanisms of action are not fully understood; however, caries arrest likely results because cariogenic bacteria are killed by the silver compounds, and colonization is reduced because the pathogens are unable to form a biofilm on SDF-treated dentinal surfaces.[16] The fluoride ion facilitates remineralization, with formation of fluorapatite from the original hydroxyapatite crystals.[17] The insoluble crust, which forms after treatment, also serves as a fluoride reservoir for reducing the impact of acid challenges and increases dentin hardness.[18,19]

In the summer of 2014, SDF was cleared by the U.S. Food and Drug Administration. It became commercially available the following spring. Like fluoride varnish, its label indication is desensitization for use on individuals over 21 years of age. However, several large clinical trials have shown the effectiveness and safety as a caries control agent in young children and that it can be used legally off-label by licensed professionals.[8-12] Similarly, off-label use of fluoride varnish has become the gold standard of caries prevention and early caries management.[20,21] SDF promises to outperform fluoride varnish for caries arrest and to become an invaluable tool for caries prevention and management.[22] Understanding current use and teaching practices is a prerequisite for curriculum change and practice innovation.[6]

The purpose of this baseline study was to document current practice, teaching, and perceived barriers to use of SDF and other caries control agents in U.S. pediatric dentistry residency programs.

Methods

Participants. Pediatric dentistry residency program directors (74 sites) and associate program directors (Lutheran Medical Center residency program, 13 sites; N equals 87) were surveyed. Contact information was obtained from *www.aapd.org*.

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Survey methods. The staff of Advantage Dental Services in Redmond, Ore., USA, with experience in patient case management and research, administered the survey. An initial survey announcement email from the investigative team was sent to each program director on July 24, 2015. Survey participants responded by either using a web-based survey tool, completing a paper and pencil survey instrument, or interview. The introductory email contained a personalized cover letter on University of Washington letterhead, a Microsoft Word (Microsoft, Inc., Redmond, Wash., USA) survey attachment, and a link to the web-based survey. Four weeks after the initial mailing, a reminder email was sent to all directors who had not yet responded. A second and final email reminder was sent eight weeks after the initial mailing. One week after the second reminder, the remaining directors were contacted via telephone and provided survey materials if they chose to participate. The end date of the survey was November 30, 2015. Completion of the survey served as implied consent. The Institutional Review Board of the University of Washington determined that the survey was exempt.

Survey instrument. The questionnaire included 14 items relating to use and teaching of caries control agents in pediatric dentistry residency programs. Questions included Likert-style, multiple choice, and fill-in responses. Directors were queried regarding the location and type of their program, their own practice experience, and years in the director position. Several questions covered current use, teaching, and expectations for future use of caries control agents. Other survey items investigated perceived indications for use of SDF and barriers to implementation in residency clinics. Finally, respondents were asked about specifics of use within their institution, including the protocol for application.

Data analysis. Responses were tabulated in Microsoft Excel (Microsoft, Inc.) and subsequently analyzed using Stata 14.1 statistical software (StataCorp LP, College Station, Texas, USA). Frequencies and percentages were calculated for each survey item. Logistic regression was used to test bivariate associations with current use of SDF and program characteristics.

Results

Surveys were obtained from 74 residency directors or associate directors. The raw response rate was 85.1 percent, and the response rate adjusted for missing contact information was 87.1 percent. The greatest numbers of participants were directors of hospital-based programs, followed by combined and university-

Table 1. CHARACTERISTICS OF PEDIATRIC DENTISTRY RESIDENCY PROGRAMS

Characteristic	Total (N=74)	Currently use silver diamine fluoride (N=19)
	N (%)	N (%)
Programs surveyed		
Responses received	**74 (100)**	19 (26)
Response rate	**85.1**	--
Program region		
Northeast	**29 (39.2)**	9 (47.4)
South/Southeast	**20 (27.0)**	5 (26.3)
Midwest	**10 (13.5)**	1 (5.3)
West	**12 (16.2)**	4 (21.0)
Missing	**3 (4.0)**	--
Program type		
University	**11 (14.8)**	1 (5.3)
Hospital	**37 (50.0)**	10 (52.6)
Combined	**23 (31.1)**	8 (42.1)
Missing	**3 (4.0)**	--
Program directors' years in practice		
1-5	**10 (13.5)**	2 (10.5)
6-10	**13 (17.5)**	5 (26.3)
11-15	**17 (23.0)**	5 (26.3)
16-20	**4 (5.4)**	--
21+	**27 (36.5)**	7 (36.9)
Missing	**3 (4.0)**	--
Years as program director		
0-5	**48 (64.9)**	11 (57.9)
6-10	**14 (18.9)**	5 (26.3)
11-15	**6 (8.1)**	2 (10.5)
16-20	**--**	--
21+	**2 (2.7)**	1 (5.3)
Missing	**4 (5.4)**	--

Table 2. REPORTS OF USAGE AND TEACHING OF CARIES CONTROL AGENTS IN U.S. PEDIATRIC RESIDENCY PROGRAMS IN 2015 (N=74)

	Use				Teaching		
	Use currently N (%)	Expect to decrease use N (%)	Expect no change in use N (%)	Expect to increase use N (%)	Didactic N (%)	Clinical N (%)	Do not teach N (%)
Silver diamine fluoride	19 (25.7)	--	15 (20.3)	51 (68.9)	59 (79.7)	19 (25.7)	11 (14.9)
Povidone iodine	1 (1.3)	1 (1.3)	57 (77.0)	6 (8.1)	43 (58.1)	2 (2.7)	31 (41.9)
Silver nitrate	7 (9.5)	2 (2.7)	54 (73.0)	10 (13.5)	46 (62.2)	6 (8.1)	27 (36.5)
Fluoride varnish	74 (100)	--	61 (82.4)	7 (9.5)	69 (93.2)	70 (94.6)	--
Acidulated phosphate fluoride foam	36 (48.6)	7 (9.5)	60 (81.1)	--	63 (85.1)	38 (51.4)	6 (8.1)

Table 3. PERCEIVED INDICATIONS AND BARRIERS TO THE USE OF SILVER DIAMINE FLUORIDE IN U.S. PEDIATRIC DENTISTRY RESIDENCY PROGRAMS IN 2015 (N=74)

	Very strongly agree N (%)	Strongly agree N (%)	Agree N (%)	Disagree N (%)	Strongly disagree N (%)	Missing N (%)
Perceived indications for silver diamine fluoride						
High caries-risk patients	30 (40.5)	21 (28.4)	15 (20.3)	5 (6.8)	--	3 (4.0)
Cavitated lesions						
Primary teeth	24 (32.4)	15 (20.3)	26 (35.1)	7 (9.5)	--	3 (4.0)
Permanent teeth	8 (10.8)	11 (14.9)	30 (40.5)	20 (27.0)	1 (1.3)	4 (5.4)
Incipient lesions (enamel intact)						
Primary teeth	3 (4.0)	7 (9.5)	25 (33.8)	29 (39.2)	6 (8.1)	4 (5.4)
Permanent teeth	2 (2.7)	7 (9.5)	22 (29.7)	26 (35.1)	13 (17.6)	4 (5.4)
Patients who cannot receive conventional treatment						
Precooperative	26 (35.1)	24 (32.4)	18 (24.3)	4 (5.4)	--	2 (2.7)
Behavioral issues	23 (31.1)	28 (37.8)	18 (24.3)	2 (2.7)	1 (1.3)	2 (2.7)
Medically fragile	25 (33.8)	25 (33.8)	17 (230)	2 (2.7)	1 (1.3)	4 (5.4)
Logistical challenges	23 (31.1)	21 (28.4)	25 (33.8)	3 (4.0)	--	2 (2.7)
Perceived barriers to implementation of silver diamine fluoride						
Concerns regarding:						
Parental acceptance	16 (21.6)	20 (27.0)	32 (43.2)	4 (5.4)	--	2 (2.7)
Off-label use	3 (4.0)	13 (17.6)	28 (37.8)	24 (32.4)	4 (5.4)	2 (2.7)
Standard of care	6 (8.1)	18 (24.3)	26 (35.1)	18 (24.3)	3 (4.0)	3 (4.0)
Evidence base	8 (10.8)	14 (18.9)	25 (33.8)	23 (31.1)	2 (2.7)	2 (2.7)
Reimbursement	7 (9.5)	13 (17.6)	34 (45.9)	15 (20.3)	3 (4.0)	2 (2.7)
Residents have inadequate training	6 (8.1)	13 (17.6)	22 (29.7)	26 (35.1)	5 (6.8)	2 (2.7)
Obtaining product	9 (12.2)	12 (16.2)	21 (28.4)	24 (32.4)	6 (8.1)	2 (2.7)
Cost	10 (13.5)	5 (6.8)	28 (37.8)	25 (33.8)	4 (5.4)	2 (2.7)

based programs. Responses generally mirrored the distribution of pediatric dentistry residency programs. The number of years since the participants had received their training in pediatric dentistry was distributed relatively evenly between more recent graduates and older practitioners, with the majority having over 10 years experience since graduation. While participants were generally not recent graduates, most had been in the residency director position for less than five years (64.9 percent). Odds ratios for use of SDF were calculated for all variables in Table 1 (data not shown); however, use was not associated with program region, program type, or residency director experience (Table 1).

Table 2 reports usage and teaching of caries control agents in residency programs in 2015. Approximately one quarter (25.7 percent) of the programs used SDF, and less than 10 percent used silver nitrate. Teaching practices for caries control agents generally followed clinical usage; however, SDF and silver nitrate were more frequently taught in didactic coursework than in clinical practice. Fluoride varnish was the most frequently used agent (100 percent), followed by acidulated phosphate fluoride foam (**APF**) (48.6 percent). Only one program used povidone iodine.

Most program directors reported SDF was indicated for high caries-risk patients only (89.2 percent), and the majority agreed with use in cavitated lesions for both primary teeth and permanent teeth. However, over one quarter of the directors believed that SDF should not be used in permanent teeth, while only 9.5 percent disagreed with use in primary teeth. Directors generally reported that precooperative patients, those with behavioral issues, the medically fragile, and patients facing logistical challenges were good candidates for treatment with SDF (Table 3).

The most frequently reported barrier to use of SDF was parental acceptance (91.8 percent). Directors expressed concerns regarding staining of teeth and poor parental acceptance of esthetics following treatment through multiple write-in responses. Approximately two-thirds felt off-label use, standard of care, evidence base, reimbursement, training, obtaining product, and cost were barriers to use of SDF. Program directors expressed additional concerns and barriers, including: lack of follow-up with patients treated with SDF; SDF does not restore form and function of the dentition; questions about duration of caries arrest; concerns that SDF could be applied by non-dentists; and inequities where underserved and vulnerable

children would be treated with SDF while more affluent peers would receive conventional restorative treatment.

Program directors were queried regarding practice protocols within their institution. A relatively large number (41.3 percent) indicated that they had developed materials relating to use of SDF and would be willing to share with others. Most (82.4 percent) felt written consent should be obtained from parents/caregivers when using the agent. Regarding application frequency, 39 (52.7 percent) felt that only a single application would be needed to achieve arrest, while 24 (32.4 percent) felt that multiple applications would be needed over several weeks. Similarly 40 (54.0 percent) directors expressed that only a single application would be needed to maintain arrest in previously arrested lesions, while 23 (31.1 percent) felt that SDF should be applied twice annually. Most (60.8 percent) were not familiar with the CDT code for caries arrest, which was introduced in CDT 2016: Dental Procedure Codes (http://www.ada.org/en/publications/ada-catalog/cdt-products).

Program directors were also surveyed regarding prescription of the preventive agents CCP-ACP paste, 5,000 ppm fluoride toothpaste, chlorhexidine, and xylitol in residency program clinics. The most frequently prescribed agent was 5,000 ppm fluoride toothpaste, with 77.3 percent of directors reporting use with high caries-risk patients. Chlorhexidine and xylitol products were the next most frequently prescribed agents at 38.7 percent and 36 percent, respectively. CCP-ACP paste was prescribed in 28 percent of programs.

Discussion

Curriculum surveys of pediatric dentistry residency programs are rare. A review of the literature identified only a few studies, and none specifically focused on teaching of prevention or disease management.[4,7,23] The purpose of this baseline survey was to determine current knowledge and use of caries control agents within the curriculum and clinics of residency programs. There was a specific emphasis on SDF, as this product was new to the U.S. market in 2015, and its impact on the curriculum was unknown. Most pediatric dentistry residency programs responded. Thus, the sample included diverse program types and locations and directors with varying levels of experience.

Use of SDF in pediatric residency programs. SDF has been rapidly incorporated into curriculum and clinical practice residency programs. This baseline survey was administered less than six months after SDF was first introduced into the United States, and already over 25 percent of training programs reported using it in residency clinics. Curiously, while silver nitrate has been widely available and discussed in public health circles since at least 2012,[14] it was reported in less than 10 percent of programs. This may reflect its relatively weak evidence base and the fact that there are no products marketed specifically for dental use. Similarly, while povidone iodine in high caries-risk children has been discussed in the literature for some time, only one program was currently using it.[24-26] This also may reflect the lack of randomized controlled trials evaluating it and the lack of commercial products that focus on dental use.

SDF is new to the United States, and themes that emerged from the surveys suggest that many program directors did not feel fully able to answer questions and needed to gain familiarity with the agent. Others expressed a desire to learn what colleagues had to say about SDF and other caries control agents and were interested in receiving materials on SDF and in longer-term evidence-based research regarding its use.

Indications for SDF use in residency training. Participants were given a list of possible indications for use of SDF. Nearly all agreed with its use in children of precooperative age, difficult behavior, medically fragile patients, and those who face logistical challenges. Many studies have demonstrated efficacy in the pediatric population, supporting the opinions cited by program directors.[8,11,13,27] Recently a report was published highlighting how SDF was used to stabilize caries and reduce permanent tooth sensitivity in a severely immunocompromised Chinese teenager.[28] This provides an example of how contemporary caries control agents can be used in conjunction with conventional restorative treatment or when conventional treatment is not an option because of a patient's medical status.

Interestingly, over twice as many respondents disagreed that SDF should be used in permanent teeth versus primary teeth. This may reflect concerns regarding use of unfamiliar agents in teeth that will not exfoliate, but it may also relate to research suggesting that SDF is more effective in primary teeth than permanent teeth. In 2005, Llodra et al. published a comparison of caries arrest in primary canines and molars versus permanent first molars. Their findings suggest that, when SDF was applied twice annually for three years, the preventive fraction of new caries in primary teeth was greater.[11] Although the topic of lesion location was not specifically addressed in the present survey, Zhi et al. reported a higher rate of caries arrest in both primary anterior teeth and buccal/lingual smooth surfaces. They reported that caries lesions in buccal or lingual tooth surfaces had a 15.6 times chance of becoming arrested when compared with occlusal or proximal surfaces and that primary anterior teeth were 5.5 times more likely to become arrested relative to posterior teeth.[9] Nevertheless, the raw arrest rate in both studies is relatively high.

Barriers to SDF use in residency program clinics. Incorporating new knowledge into clinical practice can be a slow process. Rogers cited a number of barriers to diffusion of innovation. These include economics, incompatibility with existing value systems, and complexity of the innovation.[29] While there appears to be robust support for introduction of SDF in training programs, many expressed concern regarding barriers to use. The most frequently cited concern was parental acceptance of esthetics; this is likely the reason that over 80 percent responded that parents should sign written consents before SDF is administered. After we conducted our survey, Horst et al. published a protocol for SDF use. Their paper includes a consent form with color photographs, so that parents/caregivers can make informed decisions about benefits and risks, including post-treatment lesion color changes.[15] Figures 1 and 2 show examples of the color change in carious lesions that indicates successful arrest after SDF treatment.

Horst's protocol is well referenced and complete; nevertheless, there is a need for guidelines from the American Academy of Pediatric Dentistry (**AAPD**). Future guidelines should address concerns of program directors regarding standard of care and evidence base. Current systematic reviews can provide the basis for guidelines, and U.S.-based studies currently being conducted will provide additional scientific evidence.

Surprisingly, some directors raised cost as a barrier. This may be a result of their unfamiliarity with the product and limited advertising in this early period. Currently, SDF is only available through Elevate Oral Care LLC (West Palm Beach, Fla., USA), at a cost of roughly $125 per eight mL bottle. The manufacturer suggests that each bottle contains product for

Figure 1. Primary Incisors Before SDF Treatment.

Figure 2. Primary Incisors After SDF Treatment.

approximately 100 applications. Therefore, the materials cost is similar to agents such as fluoride varnish that are routinely used in pediatric practice.[30] Likewise, 60 percent of directors were not familiar with CDT code D1354, which is now available for caries arrest. As insurers adopt this code, reimbursement will likely be less of a barrier. Although SDF is now available throughout the United States, hospital-based programs mentioned that adding a new item to hospital inventory presents an additional barrier. Some participants also said that acceptance of faculty, especially part-time or affiliates, would be a barrier to implementation.

Curriculum implications and rate of adoption. While little has previously been published on caries management curricula, a 2013 survey of Atraumatic Restorative Treatment (**ART**) in residency programs provides some insight into the adoption curve for new clinical practices.[7] ART was developed in the 1980s as an affordable caries management procedure that could be implemented with minimal equipment and operator training. Over time, the technique gained traction in dental communities, and is now recognized by the World Health Organization and the International Dental Federation as part of the basic package of oral care for communities throughout the world.[31] In the 2011 revision of policy statements, the AAPD recognized ART as a definitive treatment in populations with limited access to dental care. The AAPD now also recognizes the interim therapeutic restoration (**ITR**), which is similar to ART in its focus on interim caries management.[32] The 2013 survey reported that 89 percent of programs provided clinical instruction on ART, with 30 percent using the technique very often or often.[7] Thus, nearly full adoption required several decades.

Like ART and ITR, use of SDF was initiated in the international community, but this time adoption by U.S. training programs appears to be more rapid than with these earlier technologies. Most residency program directors anticipated that use of SDF would increase. Many specifically expressed optimism that SDF would be helpful for patients who are unable to receive conventional restorative treatment or are awaiting dental treatment under general anesthesia.

Conclusions

Based on this study's results, the following conclusions can be made:

1. Silver diamine fluoride was being rapidly adopted in graduate pediatric dentistry training programs. Most expected to incorporate SDF into their teaching clinics and curricula.
2. The most-cited barrier to use of SDF was perceived parent/caregiver acceptance of color changes associated with caries arrest.

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References

1. Commission on Dental Accreditation. Accreditation Standards for Dental Education Programs. Chicago, Ill., USA: American Dental Association; 2015.
2. Casamassimo P, Berlocher WC, Cheney W, et al. The future of pediatric dentistry advanced education: the need for change in training standards. Pediatr Dent 2009;31: 298-309.
3. Ramos-Gomez FJ, Silva DR, Law CS, et al. Creating a new generation of pediatric dentists: a paradigm shift in training. J Dent Educ 2014;78:1593-603.
4. Riley JL, Richman JS, Rindal DB, et al. Use of caries-preventive agents in children: findings from the dental practice-based research network. Oral Health Prev Dent 2010;8:351-9.
5. Narendran S, Chan JT, Turner SD, Keene HJ. Fluoride knowledge and prescription practices among dentists. J Dent Educ 2006;70:956-64.
6. Brown JP. A new curriculum framework for clinical pre-][vention and population health, with a review of clinical caries prevention teaching in U.S. and Canadian dental schools. J Dent Educ 2007;71:572-8.

7. Kateeb E, Warren J, Damiano P, et al. Atraumatic Restorative Treatment (ART) in pediatric dentistry residency programs: a survey of program directors. Pediatr Dent 2013; 35:500-5.
8. Chu CH, Lo EC, Lin HC. Effectiveness of silver diamine fluoride and sodium fluoride varnish in arresting dentin caries in Chinese pre-school children. J Dent Res 2002; 81:767-70.
9. Zhi QH, Lo EC, Lin HC. Randomized clinical trial on effectiveness of silver diamine fluoride and glass ionomer in arresting dentine caries in preschool children. J Dent 2012;40:962-7.
10. Yee R, Holmgren C, Mulder J, et al. Efficacy of silver diamine fluoride for arresting caries treatment. J Dent Res 2009;88:644-7.
11. Llodra JC, Rodriguez A, Ferrer B, et al. Efficacy of silver diamine fluoride for caries reduction in primary teeth and first permanent molars of schoolchildren: 36-month clinical trial. J Dent Res 2005;84(8):721-4.
12. Gotjamanos T. Pulp response in primary teeth with deep residual caries treated with silver fluoride and glass ionomer cement ("atraumatic" technique). Aust Dent J 1996; 41:328-34.
13. Fung M, Wong M, Lo E, Chu C. Arresting early childhood caries with silver diamine fluoride: a literature review: Oral Hyg Health 2013;1:117. doi: 10.4172/2332-0702. 1000117.
14. Duffin S. Back to the future: the medical management of caries introduction. J Calif Dent Assoc 2012;40:852-8.
15. Horst J, Ellenikiotis E, Milgrom P. UCSF Protocol for caries arrest using silver diamine fluoride: rationale, indications, and consent. J Calif Dent Assoc 2016;44:16-28.
16. Vasquez E, Zegarra G, Chirinos E, et al. Short term serum pharmacokinetics of diammine silver fluoride after oral application. BMC Oral Health 2012;12:60.
17. Nyvad B, ten Cate JM, Fejerskov O. Arrest of root surface caries in situ. J Dent Res 1997;76:1845-53.
18. Mei ML, Chu CH, Lo EC, Samaranayake LP. Fluoride and silver concentrations of silver diammine fluoride solutions for dental use. Int J Paediatr Dent 2013;23:279-85.
19. Mei ML, Ito L, Cao Y, et al. Inhibitory effect of silver diamine fluoride on dentine demineralisation and collagen degradation. J Dent 2013;41:809-17.
20. Lenzi TL, Montagner AF, Soares FZ, de Oliveira Rocha R. Are topical fluorides effective for treating incipient carious lesions? A systematic review and meta-analysis. J Am Dent Assoc 2016;147:84-91.
21. Weyant RJ, Tracy SL, Anselmo TT, et al. Topical fluoride for caries prevention: executive summary of the updated clinical recommendations and supporting systematic review. J Am Dent Assoc 2013;144:1279-91.
22. Rosenblatt A, Stamford TC, Niederman R. Silver diamine fluoride: a caries "silver-fluoride bullet." J Dent Res 2009; 88(2):116-25.
23. Wilson S, Nathan JE. A survey study of sedation training in advanced pediatric dentistry programs: thoughts of program directors and students. Pediatr Dent 2011;33: 353-60.
24. Amin MS, Harrison RL, Benton TS, Roberts M, Weinstein P. Effect of povidone-iodine on *Streptococcus mutans* in children with extensive dental caries. Pediatr Dent 2004; 26:5-10.
25. Lopez L, Berkowitz R, Spiekerman C, Weinstein P. Topical antimicrobial therapy in the prevention of early childhood caries: a follow-up report. Pediatr Dent 2002;24:204-6.
26. Simratvir M, Singh N, Chopra S, Thomas AM. Efficacy of 10 of povidone iodine in children affected with early childhood caries: an in vivo study. J Clin Pediatr Dent 2010;34: 233-8.
27. Chu CH, Lo EC. Promoting caries arrest in children with silver diamine fluoride: a review. Oral Health Prev Dent 2008;6:315-21.
28. Chu CH, Lee AH, Zheng L, Mei ML, Chan GC. Arresting rampant dental caries with silver diamine fluoride in a young teenager suffering from chronic oral graft versus host disease post-bone marrow transplantation: a case report. BMC Res Notes 2014;7:3.
29. Rogers E. Diffusion of Innovation. 5th ed. New York, N.Y., USA: Free Press; 2003:168-180, 189-90.
30. Advantage Arrest, Elevate Oral Care, LLC. West Palm Beach, Fla., USA.
31. Frencken JE. Evolution of the the ART approach: highlights and achievements. J Appl Oral Sci 2009;17(suppl): 78-83.
32. American Academy on Pediatric Dentistry Council on Clinical Affairs. Policy on interim therapeutic restorations (ITR). Pediatr Dent 2008;30(suppl 7):38-9.