

# Silver Diamine Fluoride (SDF) as a Nonrestorative Treatment for Caries Lesions

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# Disclosures

- CIHR Embedded Clinician Researcher in Improving access to oral health care and oral health care delivery for at-risk young children in Manitoba
- Co-chair Canada-US Chapter of the Alliance of a Cavity Free Future (ACFF)
- Section Head, Pediatric Dentistry, Winnipeg Regional Health Authority
- Chair, Canadian Dental Association's Committee on Clinical and Scientific Affairs



# Objectives

We will review:

- Literature on Silver Diamine Fluoride (SDF)
- Lessons from others on SDF and silver ion products
- Results from SDF feasibility study in Winnipeg
- Review Clinical Guidelines for SDF



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## Conclusions:

### Review

## Silver compounds used in dentistry for caries management: A review

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### ABSTRACT

**Objective:** Silver compounds have been used for their medical properties for centuries and in dentistry for more than a century. The aim of this review is to examine the evidence supporting the therapeutic use of silver in dentistry and the outcomes from the clinical trials, as well as mode of action and biocompatibility.

**Data sources:** Literature was searched using the PubMed database between the year 1966 and 2011, with principle key terms such as "Silver Nitrate", "Silver Fluoride", "Silver Diammine Fluoride", "Silver compounds" and "Dental caries". Hand searching was performed for

- Silver compounds are effective anti-caries agents
- Incomplete understanding of how they work
- Further research required

# History of Silver Ions in Dentistry

- Silver Nitrate used globally for >1000 years.
  - ❑ Caries arrest case series & protocols in 1800s
- AgF used in Japan for ~900 years.
  - ❑ Cosmetic blackening of teeth
  - ❑ Known to prevent caries
- Ammonia ( $\text{NH}_3^+$ ) added >80 years ago = SDF
- Dr. G.V. Black used multiple applications of silver nitrate solution to slow the progression of caries.
- 1920's ammoniacal silver nitrate used by Dr. Howe for caries reversal, the chemical precursor of SDF.
- 1936 Silver nitrate was investigated for preventing enamel caries, unsuccessfully, based on its known dentinal hardening properties.
- 1973 Canadian study Dr. Hyde undertook an 18 month randomized trial of a single application of silver nitrate, stannous fluoride, and phosphate fluoride to inhibit early caries lesions. He concluded that silver nitrate did significantly retard the progress of dental caries and did not report any side effects or safety issues.



# Silver Diamine Fluoride (SDF) – A Shift in Paradigm

- Until recently there have been no effective non-surgical products available for secondary prevention of caries.
- Though primary prevention is always preferred, safe, effective, feasible, and acceptable, secondary prevention can reduce the morbidity from a disease, and preserve the function of affected primary teeth until natural exfoliation.
- SDF represents a minimally-invasive approach to the management of caries that has traditionally focused on surgical intervention.

# Silver Diamine Fluoride (SDF) – A Shift in Paradigm

- There is no clear protocol for dental professionals to follow for arresting caries in young children, it is paramount that there be studies into the feasibility, effectiveness, and acceptability of this product to manage and arrest caries.
- Without such investigations, there is concern that some dental professionals may use this product without sufficient consideration for appropriate case selection
- This may result in harm or negative perceptions of a potentially beneficial product that is a safe and effective secondary prevention agent.

# SDF – What is it? What does it do?

- Colorless liquid composed of silver, ammonia and sodium fluoride
  - Silver exerts antimicrobial action on cariogenic bacteria
  - Sodium fluoride: a) promotes remineralization; b) inhibits demineralization; and c) inhibits plaque bacteria
  - Ammonia stabilizes the high concentration in solution
- Arrests dental caries
- Prevents dental caries
- Decreases dentin hypersensitivity

# Advantages of SDF

- Arrests cavitated caries lesions
- May control pain by arresting caries
- Affordable option
- Minimal support in staff or equipment required (in some instances)
- Non-invasive and safe to use in children – but depends on severity of lesion(s)
- Useful in high-risk populations

- SDF has been used in Japan since the 1960s and in Australia, Brazil, Argentina, Mexico and China since the 1980s
- It was approved for use in the U.S.A. by the Food and Drug Administration in 2014 as Advantage Arrest (Elevate Oral Care)
- Health Canada approved 38% SDF Advantage Arrest (Oral Science) in February 2017



Image: [www.oralscience.ca](http://www.oralscience.ca)



# Advantage Arrest

Per application cost

- \$149 = 8 mL bottle = 250 drops = \$0.52/Drop
- \$11.25 for 100 Applicators – \$0.11 per app.
- One drop application = \$0.63 per application
- Two drop application = \$1.26 per application
- *Equal or less than Fluoride Varnish*



# Disadvantages

- The affected area will stain black permanently.
  - Healthy tooth structure will not stain.
- Tooth-coloured fillings and crowns may also discolour
- STAINS: skin and lips (temporary), clothing (permanently), surfaces in the dental office, including countertops (permanently)
- Can irritate gingival tissues.
- If tooth decay is not arrested, the decay will progress; tooth will require further treatment, such as repeat SDF, a filling or crown, root canal or extraction.
- Contraindication: silver allergy.



IN BRIEF A Summary of the Evidence

## Silver Diamine Fluoride for the Prevention and Arresting of Dental Caries or Hypersensitivity: A Review

### Key Messages

- Silver diamine fluoride appears to be effective for the arrest and prevention of dental caries (tooth decay) in children and elderly patients; however, the evidence is limited.
- Two systematic reviews on the use of silver diamine fluoride reported tooth discolouration, whereas a primary study involving elderly patients found no adverse effects; however, adverse events associated with silver diamine fluoride are generally not well reported in the literature.
- One study found that children experience less discomfort with silver diamine fluoride treatment compared with resin infiltration treatment.
- A study conducted in Germany found silver diamine fluoride to be more cost-effective than fluoride rinses and chlorhexidine for the prevention of dental caries in the elderly, but this finding might not be applicable to a Canadian context.
- One clinical guideline suggests that silver diamine fluoride treatment may benefit the dental health of children and youth; however, it was unknown whether the benefits would outweigh potential harms, so no recommendation on its use could be provided.
- Another guideline states that silver diamine fluoride can irritate the gums and darken and discolour teeth but appears to be well-tolerated overall, and recommended that it could be a useful agent in populations that would benefit from a less-invasive approach than traditional surgical treatment (dental fillings) or who have trouble accessing dental care.
- No evidence was found on the use of silver diamine fluoride for tooth hypersensitivity.

### Context

The conventional method of treating dental caries involves surgically removing the infected and softened dental tissue from the tooth and then filling the resulting hole with restorative material. The invasive nature of this treatment can make it difficult for some patients – for example, children and those with special needs – to tolerate. Silver diamine fluoride has, therefore, been developed as a potential non-surgical alternative to conventional restorative treatment.

### Technology

Silver diamine fluoride is a liquid treatment that is applied to the teeth, making it less invasive than traditional procedures for treating dental caries. It has been used for many decades in Japan and other countries for the prevention and arrest of dental caries. In February 2017, 38% silver diamine fluoride was approved for use in Canada. Silver diamine fluoride is thought to have antimicrobial properties and to promote remineralization. It is also thought to cause relatively minimal adverse events, such as tooth discolouration and irritation to the gums.

### Issue

A review of the clinical effectiveness, cost-effectiveness, safety, and guidelines related to silver diamine fluoride for the prevention and arrest of dental caries or hypersensitivity will help guide decisions regarding its use.

### Methods

A limited literature search was conducted of key resources, and titles and abstracts of the retrieved publications were reviewed. Full-text publications were evaluated for final article selection according to predetermined selection criteria (population, intervention, comparator, outcomes, and study designs).

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# Clinical Applications for SDF

- To arrest cavitated caries lesion in primary and permanent teeth
- For the fearful and apprehensive patient
- To delay restorative treatment until child is older and avoid a GA
- To arrest and prevent progression of caries in children being referred for GA and on GA wait lists



# SDF – How Does it Work?

- SDF inhibits dentin demineralization, increases dentin hardness, preserves collagen and inhibits collagen breakdown
- Forms silver-protein conjugate on decayed dentin, increasing resistance to acid dissolution and enzymatic digestion
- Hydroxyapatite and fluorapatite form on exposed organic matrix
- Inhibits proteins that break down exposed dentin organic matrix



Photos courtesy of Dr. R. Schroth

- No benefit to caries removal prior to the application of SDF (Chu et al., 2002)
- SDF has been shown to be more effective than interim restorative treatment and glass ionomer (Zhi et al., 2012)
- SDF found to be more effective than sodium fluoride varnish in arresting caries (Duangthip et al., 2016)
- Biannual application of SDF found to be more effective than annual application (Fung et al., 2017)

# Color stain? Potassium Iodide



- Reduces Ag to *white* oxidation state
- In vitro studies show no impact on antimicrobial effect
- It does decrease stain
- Avoid potassium iodide in pregnant or lactating women
- Potassium iodide application prevents the black stain on the affected dentin with SDF but not with silver nitrate.





## Silver Diamine Fluoride Has Efficacy in Controlling Caries Progression in Primary Teeth: A Systematic Review and Meta-Analysis

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### Keywords

Cariostatic agents · Child · Dental caries · Systematic review

### Abstract

A systematic review was performed to evaluate the efficacy of silver diamine fluoride (SDF) in controlling caries progression in children when compared with active treatments or placebos. A search for randomized clinical trials that evaluate the effectiveness of SDF for caries control in children compared to active treatments or placebos with follow-ups longer than 6 months was performed in PubMed, Scopus, Web of Science, LILACS, BBO, Cochrane Library, and grey literature. The risk of bias tool from the Cochrane Collaboration was used for quality assessment of the studies. The quality of the evidence was evaluated using the GRADE approach. Meta-analysis was performed on studies considered at low risk of bias. A total of 5,980 articles were identified. Eleven remained in the qualitative synthesis. Five studies were at “low,” 2 at “unclear,” and 4 studies at “high” risk of bias in the key domains. The studies from which the information could be extracted were included for meta-analysis. The arrestment of caries at 12 months promoted by SDF was 66% higher (95% CI 41–91%;  $p < 0.00001$ ) than by other active material, but it was 154% higher (95% CI 67–85%;  $p < 0.00001$ ) than by placebos. Overall, the caries arrestment was 89%

higher (95% CI 49–138%;  $p < 0.00001$ ) than using active materials/placebo. No heterogeneity was detected. The evidence was graded as high quality. The use of SDF is 89% more effective in controlling/arresting caries than other treatments or placebos. The quality of the evidence was graded as high.

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The water fluoridation [Koh et al., 2015] and the widespread use of fluoride toothpaste [dos Santos et al., 2013] have produced major reductions in the prevalence and incidence of dental caries leading to significant improvements in children's oral health status over the past decades [Pitts et al., 2011].

However, dental caries remains a major oral health problem. Preschool children, in contrast to other age groups, still exhibit a large number of untreated caries lesions, and the decayed number is the main component in the dmft index [Duangthip et al., 2015; Dye et al., 2015]. In Brazil, the prevalence of untreated caries lesions in 5-year-old children is very high (80%), based on the last national epidemiological survey [Brasil, 2010].

This scenario is particularly true among socioeconomically deprived groups [Pitts et al., 2011; McGrady et al., 2012; Engelmann et al., 2016; Splieth et al., 2016], and

# Evidence for SDF

- Systematic review and meta-analysis in children
- High quality evidence
- Arrest of caries at 12 months from SDF was 66% higher than by other active materials and 154% higher than placebo
- Overall, caries arrest rate was 89% higher than active material/placebo

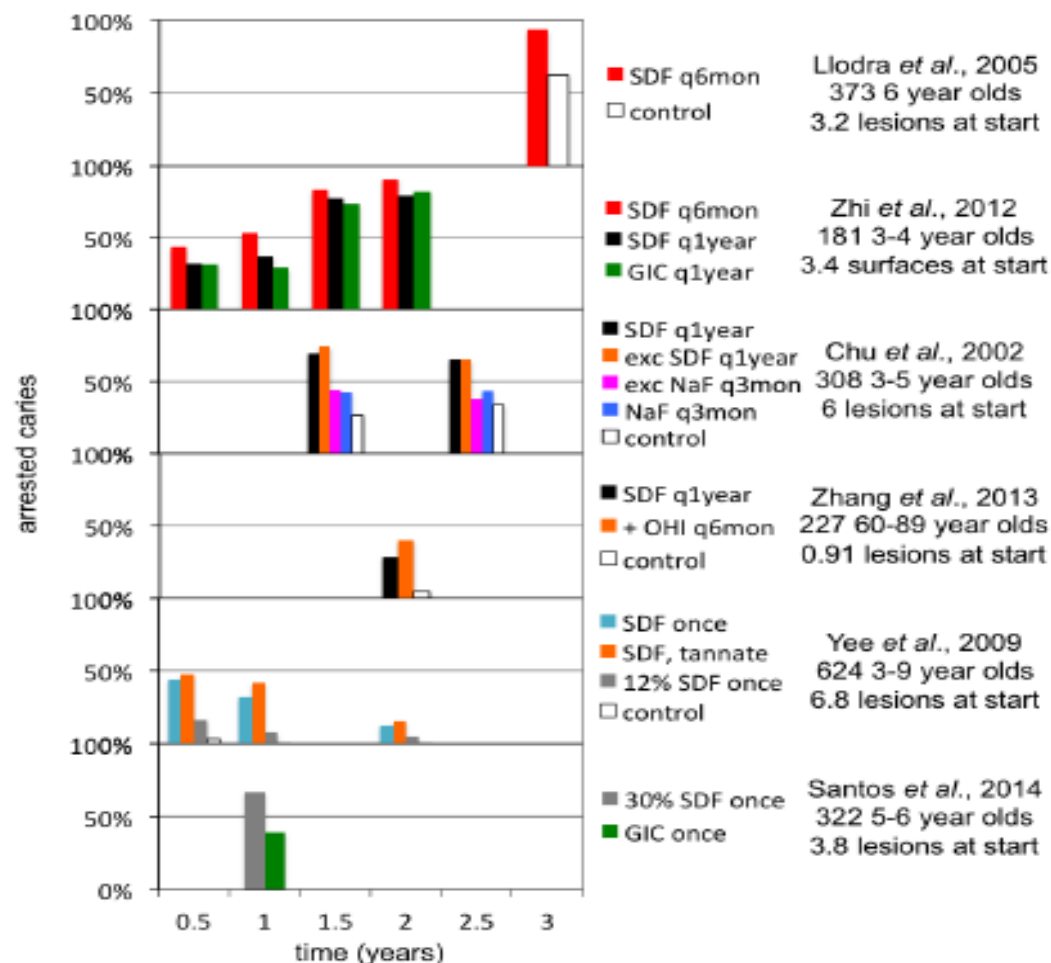


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## UCSF Protocol for Caries Arrest Using Silver Diamine Fluoride: Rationale, Indications, and Consent

Jeremy A Horst<sup>1,2</sup>, Hellene Ellenikiotis<sup>1</sup>, UCSF Silver Caries Arrest Committee, and Peter M Milgrom<sup>1,3</sup>



**Figure 1.**

Graphic summary of randomized controlled trials demonstrating caries arrest after topical treatment with 38% silver diamine fluoride (SDF). Studies are arranged vertically by frequency of silver diamine fluoride application. Caries arrest is defined as the fraction of initially active carious lesions that became inactive and firm to a dental explorer. SDF (38% unless noted otherwise); q6mon, every six months; q1year, every year; q3mon, every three months; GIC, glass ionomer cement; NaF, 5% sodium fluoride varnish; + OHI q6mon, SDF every year and oral hygiene instructions every six months.

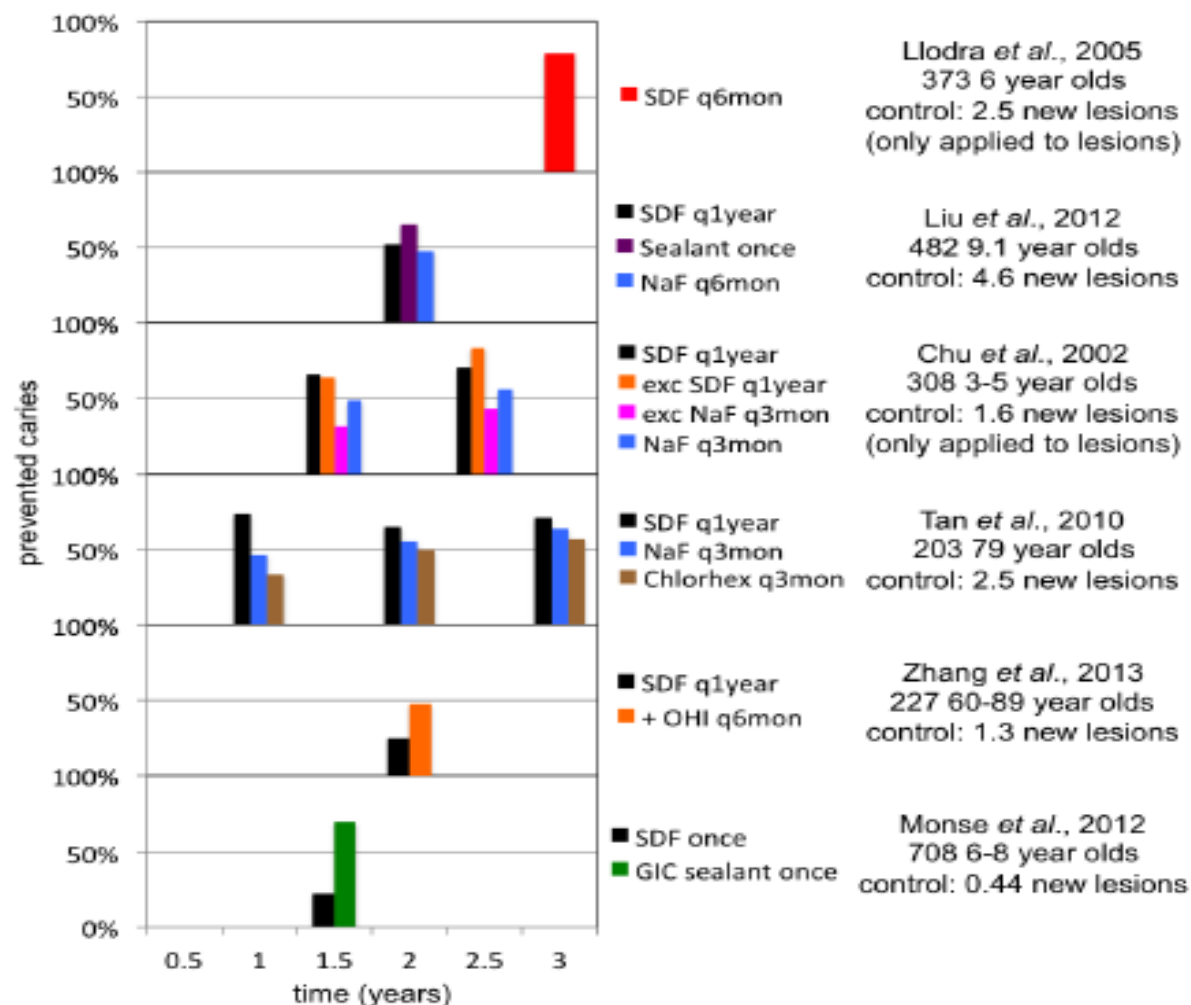


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**Figure 2.**

Graphic summary of randomized controlled trials demonstrating caries prevention after topical treatment of carious lesions with 38% silver diamine fluoride. Prevented caries is defined as the fraction of new carious lesions in treatment groups as compared to those in the placebo or no treatment control group. Chlorhex, 1% chlorhexidine varnish.

# PBS News Hour Video: This new treatment could make your next trip to the dentist more bearable

- <https://www.pbs.org/newshour/show/this-new-treatment-could-make-your-next-trip-to-the-dentist-more-bearable>

# Warms Springs Model

INDIAN HEALTH SERVICE

CDA JOURNAL, VOL 46, N°2



## The Warm Springs Model: A Successful Strategy for Children at Very High Risk for Dental Caries

Lawrence D. Robertson, MD, MPH

**ABSTRACT** American Indian/Alaska Native children have the highest dental caries prevalence in the U.S. Over several decades, Indian Health Service (IHS) implemented various caries control programs, including the recently discontinued seven-year “IHS ECC Collaborative” but without documentation of clinically significant improvement. In 2013, a single Oregon IHS dental program implemented an innovative secondary prevention strategy — now known as “the Warm Springs Model” — that dramatically reduced the need for caries treatment for children under general anesthesia.

### AUTHOR

Lawrence D. Robertson, MD, MPH, is a retired pediatrician who worked with Indian Health Service from 1981 to 2001. He has led many studies, projects and conferences on caries in American Indian children. He is currently the president of QUEST, a nonprofit organization.  
*Conflict of Interest Disclosure: None reported.*

Compared to other health problems of young children in the U.S., caries in the primary dentition is extremely common with about 23 percent of 2- to 5-year-old children having had caries experience.<sup>1</sup> However, it has a low severity for many of the children affected and often does not result in any significant decrease in their quality of life.<sup>2</sup> In contrast, in many American Indian and Alaska Native (AI/AN) communities, a large proportion of young children experience severe caries that cause pain and disability.<sup>3</sup> Decades of efforts by the Indian Health Service<sup>4</sup> (IHS) and tribal groups using all the recommended primary prevention strategies have produced no documented evidence of sustained improvement in this situation. As a result, in 2017 many AI/AN children still develop caries at a young age and still progress to experience aggressive and extensive disease. This often culminates in the need for multiple restorations and extractions under general anesthesia and results in a huge health disparity compared to the U.S. all-races rate.

### The Warm Springs Model Project

In the context of the preceding, in 2013 Frank Mendoza, DDS, — a 30-year career IHS pediatric dentist — decided to implement a different approach. His program had previously achieved a high level of performance in implementing all the recommended primary prevention strategies, including community water system fluoridation,

<sup>1</sup> Indian Health Service (IHS) is an operating division of the U.S. Department of Health and Human Services and is charged with providing health care services to elevate the health status of AI/AN people to the highest level.

- Started in 2013 in Warm Springs Indian Reservation in Oregon
- Dr. Frank Mendoz (pediatric dentist with Indian Health Service) & Dr. Dee Robertson
- Innovative secondary prevention of caries using silver nitrate and fluoride varnish

# Warm Springs Model Outcomes

TABLE 2

Outcomes of the Warm Springs Model Project at 3 ½ Years Assessed in Multiple Dimensions Including Patient-Level and Provider-Level Metrics

	Dimension	Results (210 children)
1.	Baseline patient statistics (which can provide a historical comparison of outcomes)	Baseline data: age: mean=5.9 years; dmft: mean=7.5 (range=1-20); dmfs: mean= 16.2 (range= 1-69); 84.9 percent of children < 6 years old at the baseline exam were in the highest level of severity (CIPD-4) according to the described recently published caries severity staging system. <sup>8</sup>
2.	Community, parent and staff acceptance	After 3 ½ years, Dr. Mendoza, the community, the parents and children all remain highly positive about the Warm Springs Model. In this American Indian community, it is now recognized as the “norm” as opposed to the traditional restorations approach.
3.	Emulation by other programs	Dr. Mendoza has received visits from numerous Indian health care dental providers to be trained in his model of care, plus visits by national leaders in dental public health and caries research.
4.	Proportion of patients who discontinue participation	Ninety percent remain in the protocol, though with declining rates of compliance with the recommended schedule of follow-up exams (~60 percent at 12 months after baseline, 40 percent 18 months later).
5.	<b>Patient-level clinical outcomes</b>	
	Adverse events	No serious adverse events after > 1,000 treatments.
	Fewer traumatic visits	Children consistently are more cooperative with subsequent visits because they quickly learn the visits will not be painful.
	Rate of new caries after the initial treatment	Seventy-five percent have no new caries at the 12-month follow-up (baseline data not available, but Dr. Mendoza’s clinical impression is that the rate of new caries after treatment is much lower than before).
6.	<b>Provider-level clinical outcomes*</b>	
	Number of stainless steel crowns	Five percent of children in the protocol needed treatment in the operating room for crowns and extractions (a dramatic reduction).
	Total invasive restorations	Only 14 percent of children had either SSCs, amalgam or resin restorations (a dramatic reduction).
	Restorations with glass ionomer cement	Eighty-six percent of children receiving restorations had only cosmetic or functional (prevention of food trap) restorations after caries arrest.
	Anesthesia used	General= 11; local anesthesia = 17; N <sub>2</sub> O = 68; none = 142 (a dramatic reduction in use of general and local anesthesia).

Key outcomes:

- Community and parental acceptance
- Other IHS sites adopting model
- No serious adverse events
- Fewer restorations required
- Less need for general anesthesia

\*The Warm Springs Model was a clinical practice project, so detailed comparable data for the interval prior to this project are not available for some of the parameters. Fortunately, for the most important single metric – children requiring treatment under general anesthesia – the data are available.



# Parental Perceptions and Acceptance of SDF

## ORIGINAL CONTRIBUTIONS



## Parental perceptions and acceptance of silver diamine fluoride staining

Yasmi O. Crystal, DMD; Malvin N. Janal, PhD;  
Dylan S. Hamilton, DMD; Richard Niederman,  
DMD

**S**ilver diamine fluoride (SDF) is effective for caries arrest and prevention,<sup>1</sup> particularly for the treatment of early childhood caries,<sup>2-4</sup> a disease that continues to affect certain high-risk populations at a disproportionately high rate.<sup>5</sup> The results of systematic reviews of human ran-



Supplemental material is available online.

domized controlled trials<sup>6,7</sup> substantiate that

SDF is a minimally invasive therapy that is inexpensive, does not require caries removal, is easy to apply, and poses minimal risk to patients.

The clinical observation that SDF causes dark staining of carious enamel and dentin may be a significant deterrent to its use.<sup>8,9</sup> The investigators of some clinical trials<sup>10,11</sup> have reported that parental concern about staining is low (less than 7%),<sup>10</sup> but the investigators who conducted these studies did so in settings where esthetic concerns may be different than those of parents in the United States.<sup>13</sup>

In a 2016 survey of pediatric dentistry program directors,<sup>14</sup> most of those who were surveyed agreed that SDF could be used to arrest caries in primary (87%) and permanent (66%) teeth in patients who were at high risk of experiencing caries. More than 90% of the

### ABSTRACT

**Background.** The caries arrest that can be achieved by using silver diamine fluoride (SDF) offers a minimally invasive and inexpensive alternative to traditional restorative caries treatment. The authors evaluated how the dental staining that is associated with SDF influences the acceptance of this treatment among parents of young children in the New York City metropolitan area.

**Methods.** The authors invited the parents of children who had experienced dental caries and who had appointments at the New York University Pediatric Dentistry Clinic and at several private clinics in New Jersey to participate in a Web-based survey designed to assess parents' demographics, perceptions of photographs of SDF-treated carious teeth, and acceptability of treatment in different behavior management scenarios.

**Results.** Ninety-eight mothers and 22 fathers from diverse backgrounds participated. Most parents (67.5%) judged SDF staining on the posterior teeth to be esthetically tolerable, but only 29.7% of parents made this same judgment about anterior teeth ( $P < .001$ ). In the absence of their child having behavioral barriers to conventional restorations, 53.6% of parents reported that they were likely to choose SDF to treat their child's posterior teeth, but only 26.9% of parents were likely to choose SDF to treat their child's anterior teeth. As the number of children's behavioral barriers increased, so did the parents' level of acceptance. In extreme cases, in which parents had to decide whether their children should undergo general anesthesia during treatment, parents' acceptance rate of SDF as a treatment method increased to 68.5% on posterior teeth and to 60.3% on anterior teeth. Parents' acceptance of the treatment also varied according to their socioeconomic status.

**Conclusions.** Staining on posterior teeth was more acceptable than staining on anterior teeth. Although staining on anterior teeth was undesirable, most parents preferred this option to advanced behavioral techniques such as sedation or general anesthesia.

**Practical Implications.** Clinicians need to understand parental sensitivities regarding the staining effect of SDF to plan adequately for the use of SDF as a method of caries management in pediatric patients.

**Key Words.** Caries arrest; silver diamine fluoride; parental perceptions; dental esthetics.

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This article has an accompanying online continuing education activity available at: <http://jada.ada.org/ce/home>. Copyright © 2017 American Dental Association. All rights reserved.

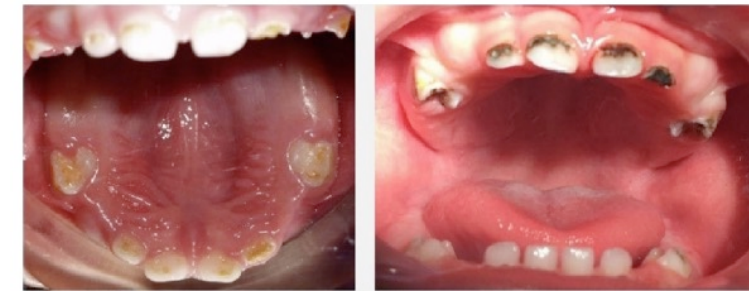
- Web-based survey to find out:
  - perceptions by looking at photos of SDF treated teeth



eFigure 1. Posterior teeth before (left) and after (right) treatment.



eFigure 2. Anterior teeth before (left) and after (right) treatment.



eFigure 3. Anterior and posterior teeth before (left) and after (right) treatment.

- acceptance of SDF in certain behavior management scenarios

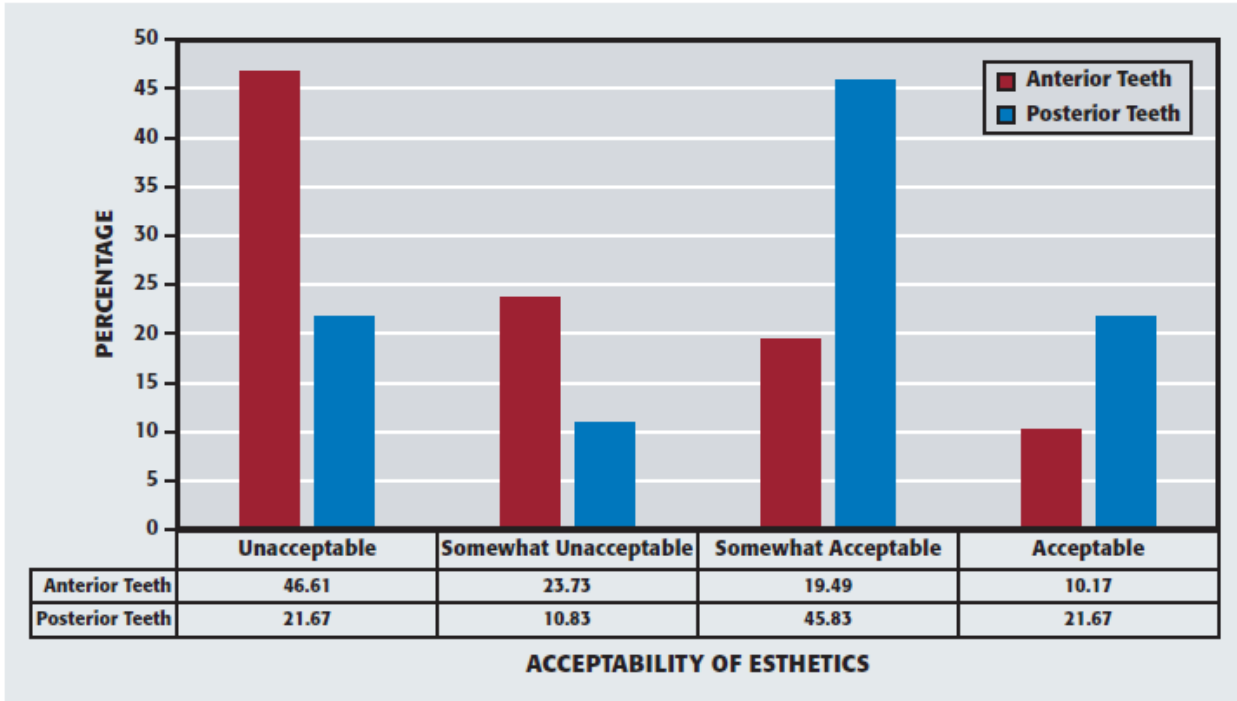


Figure 1. Percentage of acceptability on the basis of staining only.

- 67.5% said SDF staining on posterior teeth acceptable, only 29.7% said this would be acceptable in anterior
- Acceptance increased as behavioral barriers increased
- Most parents preferred SDF over other advanced management techniques like sedation or general anesthesia



# ADA Evidence-Based Clinical Practice Guideline on Nonrestorative Treatments for Carious Lesions

## Practice Guidelines

### Cover Story

#### Evidence-based clinical practice guideline on nonrestorative treatments for carious lesions

A report from the American Dental Association

Rebecca L. Slayton, DDS, PhD; Olivia Urquhart, MPH; Marcelo W.B. Araujo, DDS, MS, PhD; Margherita Fontana, DDS, PhD; Sandra Guzmán-Armstrong, DDS, MS; Marcelle M. Nascimento, DDS, MS, PhD; Brian B. Nový, DDS; Norman Tinanoff, DDS, MS; Robert J. Weyant, DMD, DrPH; Mark S. Wolff, DDS, PhD; Douglas A. Young, DDS, EdD, MS, MBA; Domenick T. Zero, DDS, MS; Malavika P. Tampi, MPH; Lauren Pilcher, MSPH; Laura Banfield, MLIS, MHSc; Alonso Carrasco-Labra, DDS, MSc

### ABSTRACT

**Background.** An expert panel convened by the American Dental Association Council on Scientific Affairs and the Center for Evidence-Based Dentistry conducted a systematic review and formulated evidence-based clinical recommendations for the arrest or reversal of noncavitated and cavitated dental caries using nonrestorative treatments in children and adults.

**Types of Studies Reviewed.** The authors conducted a systematic search of the literature in MEDLINE and Embase via Ovid, Cochrane CENTRAL, and Cochrane database of systematic reviews to identify randomized controlled trials reporting on nonrestorative treatments for non-cavitated and cavitated carious lesions. The authors used the Grading of Recommendations Assessment, Development and Evaluation approach to assess the certainty in the evidence and move from the evidence to the decisions.

**Results.** The expert panel formulated 11 clinical recommendations, each specific to lesion type, tooth surface, and dentition. Of the most effective interventions, the panel provided recommendations for the use of 38% silver diamine fluoride, sealants, 5% sodium fluoride varnish, 1.23% acidulated phosphate fluoride gel, and 5,000 parts per million fluoride (1.1% sodium fluoride) toothpaste or gel, among others. The panel also provided a recommendation against the use of 10% casein phosphopeptide–amorphous calcium phosphate.

**Conclusions and Practical Implications.** Although the recommended interventions are often used for caries prevention, or in conjunction with restorative treatment options, these approaches have shown to be effective in arresting or reversing carious lesions. Clinicians are encouraged to prioritize use of these interventions based on effectiveness, safety, and feasibility.

**Key Words.** Carious lesion; American Dental Association; practice guidelines; evidence-based dentistry; decision making; general practice; clinical recommendations; nonrestorative treatments; caries.

JADA 2018;149(10):837-849  
<https://doi.org/10.1016/j.adaj.2018.07.002>

Dental caries is a chronic noncommunicable disease that affects people of all ages worldwide. From 2015 through 2016, approximately 4 of 10 young children<sup>1</sup> and from 2011 through 2012 9 of 10 adults<sup>2</sup> were affected by caries in the United States. Although in the past decade overall caries prevalence has stabilized in both children and adults, these rates remain at a constant high for specific subgroups. According to the 2011-2012 National Health and Nutrition Examination Survey, non-Hispanic white adults aged 20 through 64 years have the highest caries prevalence rates (94%) compared with those of Hispanic, non-Hispanic black, and non-Hispanic Asian adults.<sup>2</sup> The 2015-2016 National Health and Nutrition Examination Survey data show

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- Advanced Cavitated Lesions on Any Coronal Tooth Surface:
- Arresting **advanced cavitated** carious lesions on any coronal surface of **primary teeth** – RECOMMENDS: prioritize use of 38% SDF (biannual application) over 5% NaF varnish (1/week for 3 weeks) [Moderate-certainty evidence, **strong recommendation**]

# ADA Evidence-Based Clinical Practice Guideline on Nonrestorative Treatments for Carious Lesions

## Practice Guidelines

### Cover Story

#### Evidence-based clinical practice guideline on nonrestorative treatments for carious lesions

A report from the American Dental Association

Rebecca L. Slayton, DDS, PhD; Olivia Urquhart, MPH; Marcelo W.B. Araujo, DDS, MS, PhD; Margherita Fontana, DDS, PhD; Sandra Guzmán-Armstrong, DDS, MS; Marcelle M. Nascimento, DDS, MS, PhD; Brian B. Nový, DDS; Norman Tinanoff, DDS, MS; Robert J. Weyant, DMD, DrPH; Mark S. Wolff, DDS, PhD; Douglas A. Young, DDS, EdD, MS, MBA; Domenick T. Zero, DDS, MS; Malavika P. Tampi, MPH; Lauren Pilcher, MSPH; Laura Banfield, MLIS, MHSc; Alonso Carrasco-Labra, DDS, MSc

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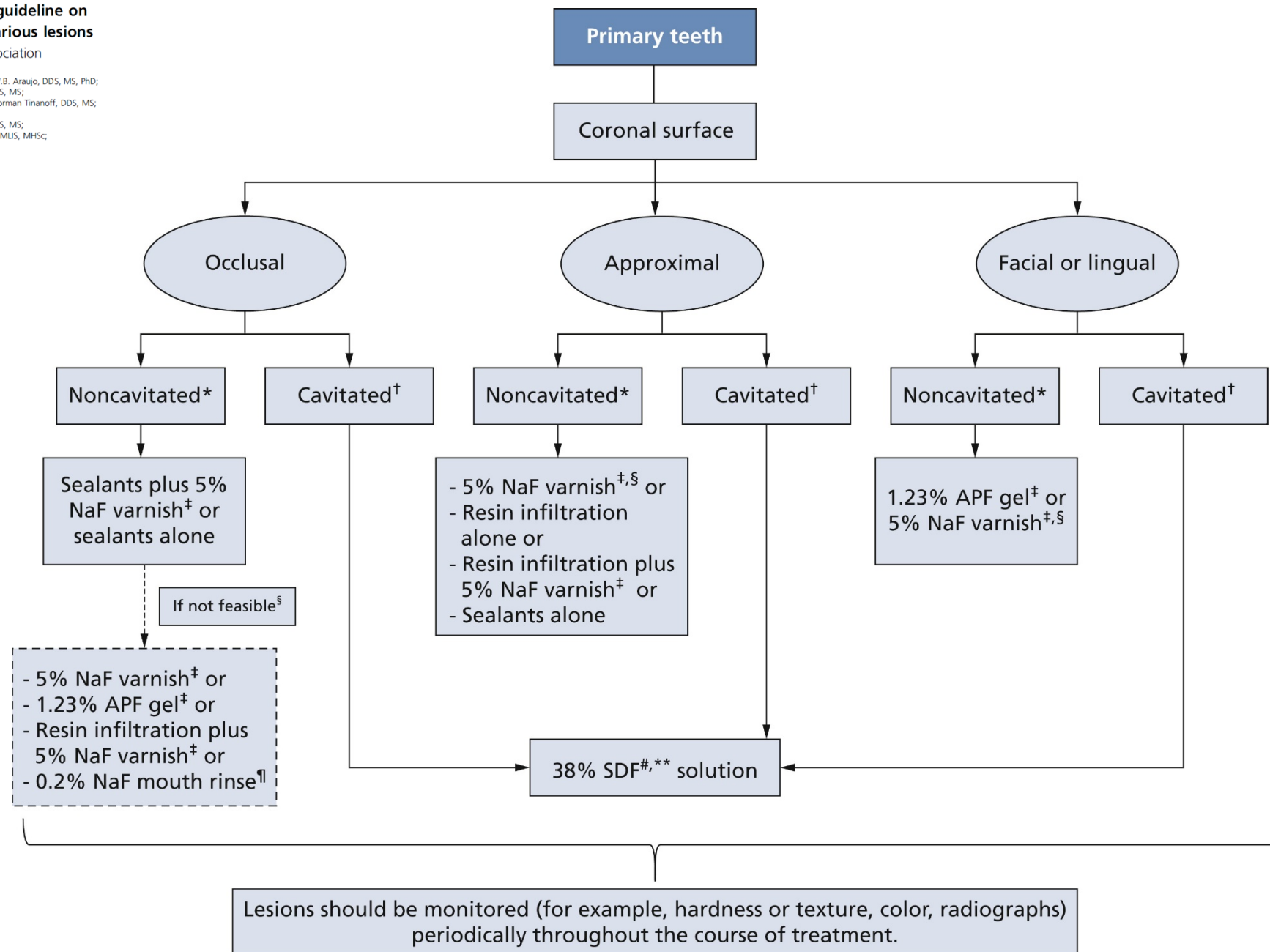
- Advanced Cavitated Lesions on Any Coronal Tooth Surface:
- Arresting **advanced cavitated** carious lesions on any coronal surface of **permanent teeth** – SUGGESTS: prioritize use of 38% SDF (biannual application) over 5% NaF varnish (1/week for 3 weeks) [Low-certainty evidence, **conditional recommendation**]

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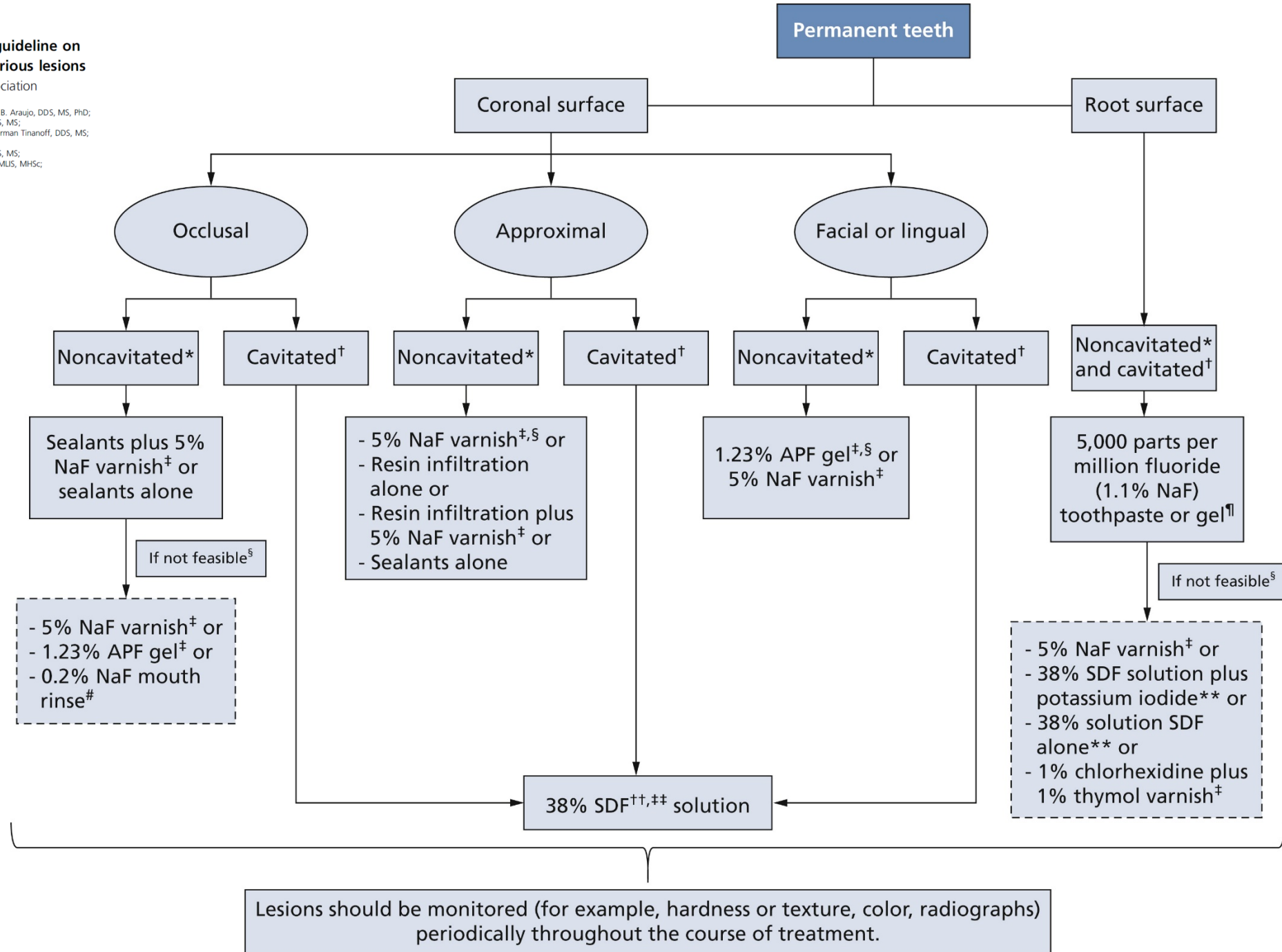


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# The Effectiveness of Silver Diamine Fluoride when used to Arrest Caries in Children and Associated Oral Health–Related Quality of Life (OHRQoL)

R Sihra, G Kyoon-Achan, M Bertone, H Martin, B Patterson, B Mittermuller, V Lee, ME Moffatt, M Fontana, B Klus, LD Robertson, RJ Schroth



COLLEGE OF  
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# Objectives

1. To determine the caries arrest rate when SDF is applied to cavitated caries lesions in young children with early childhood caries (ECC)
2. To determine the association with OHRQoL after SDF is used to treat caries lesions in young children
3. To determine parents' and caregivers' views on SDF following their participation in the study.

# Methods

- Prospective cohort pilot feasibility trial
- Mixed research methodology
- University of Manitoba HREB approved
- Written informed consent obtained from parents/legal guardians of enrolled children
- 40 children recruited from community-based dental clinics in Winnipeg (Access Downtown, Mount Carmel Clinic, and SMILE plus dental clinics)

INCLUSION CRITERIA	EXCLUSION CRITERIA
<ul style="list-style-type: none"><li>• &lt;72 months old</li><li>• Cooperative</li><li>• At least 1 carious primary tooth meeting ICDAS 5 or 6 criteria (i.e., dentinal caries) without signs of pulpal involvement</li></ul>	<ul style="list-style-type: none"><li>• Silver allergy</li><li>• Hereditary dental abnormalities</li><li>• Severe medical problems</li><li>• Emergent dental needs</li></ul>

# Methods: Data Collection

- **Baseline and follow-up questionnaire** → dental health, oral hygiene habits, diet, fluoride status, and family demographics
- **Dental assessment** → size, color, and clinical hardness of caries lesions, presence of pain or infection
- **Early Childhood Oral Health Impact Scale (ECOHIS)** → a validated questionnaire to measure the oral health-related quality of life (OHRQoL) of preschool aged children and their parents/caregivers



# Methods

BASELINE VISIT  
t = 0

- June 2017 - March 2018
- Baseline questionnaire
- Dental assessment & 1<sup>st</sup> application of SDF

SECOND VISIT  
t = 4 months

- September 2017 - July 2018
- Dental assessment & 2<sup>nd</sup> application of SDF
- 1<sup>st</sup> ECOHIS questionnaire

THIRD VISIT  
t = 8 months

- January 2018 - November 2018
- Dental assessment
- Follow-up questionnaire, 2<sup>nd</sup> ECOHIS questionnaire

QUALITATIVE  
STUDY

- January 2019 – May 2019
- Interview with parents and caregivers agreeing to be interviewed

# Methods

- Criteria for tooth selection
  - Asymptomatic
  - No clinical signs or symptoms of irreversible pulpitis or necrosis
- Criteria for lesion selection
  - International Caries Detection and Assessment System (ICDAS) 5 or 6



# Methods

- No caries excavation performed
- SDF was applied for up to 1 minute, depending on child's cooperation
- Followed by fluoride varnish (NUPRO 5% NaF white varnish)
- Assessment of treated lesions
  - Hardness: Very soft, Medium, Very hard
  - Color: Yellow, Brown, Black
- Caries lesions considered to be successfully arrested if dentin was hard and black in color, with no signs of irreversible pulpitis or infection
- Single experienced examiner involved throughout study

# Pre-treatment vs. Post-treatment



Photos courtesy of Dr. R. Schroth

# Methods

- Participants were categorized as follows:
  - Completely Successful (CS)
    - All treated lesions arrested
  - Incompletely Successful (IS)
    - At least one treated lesion not arrested
- Statistical analysis included descriptive statistics (frequencies, means, arrest rates) and bivariate statistics (t-tests, Fisher's exact tests)
- P value  $\leq 0.05$  was significant

## ECOHIS (Early Childhood Oral Health Impact Scale)

### Child Impact Section (9 questions)

**How often has your child (had)...**

#### **Child Symptoms Domain (1)**

1. pain in the teeth, mouth, or jaws?

#### **Child Function Domain (4)**

2. difficulty drinking hot/cold beverages because of dental problems/treatments?

3. difficulty eating some foods because of dental problems/treatments?

4. difficulty pronouncing any words because of dental problems/treatments?

5. missed preschool, daycare, or school because of dental problems/treatments?

#### **Child Psychological Domain (2)**

6. trouble sleeping because of dental problems/treatments?

7. been irritable or frustrated because of dental problems/treatments?

#### **Child Self-image/Social Interaction Domain (2)**

8. avoided smiling or laughing because of dental problems/treatments?

9. avoided talking because of dental problems/treatments?

### Family Impact Section (4 questions)

**How often have you or another family member...**

#### **Parent Distress Domain (2)**

10. been upset because of your child's dental problems/treatments?

11. felt guilty because of your child's dental problems/treatments?

#### **Family Function Domain (2)**

12. taken time off from work because of your child's dental problems/treatments?

13. how often has your child had dental problems/treatments that had a financial impact on your family?

#### **Response Options:**

0= never

1= hardly ever

2= occasionally

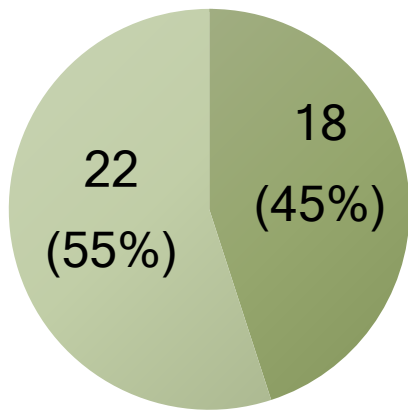
3= often

4= very often

# Results: Characteristics of Participants

SEX (n=40)

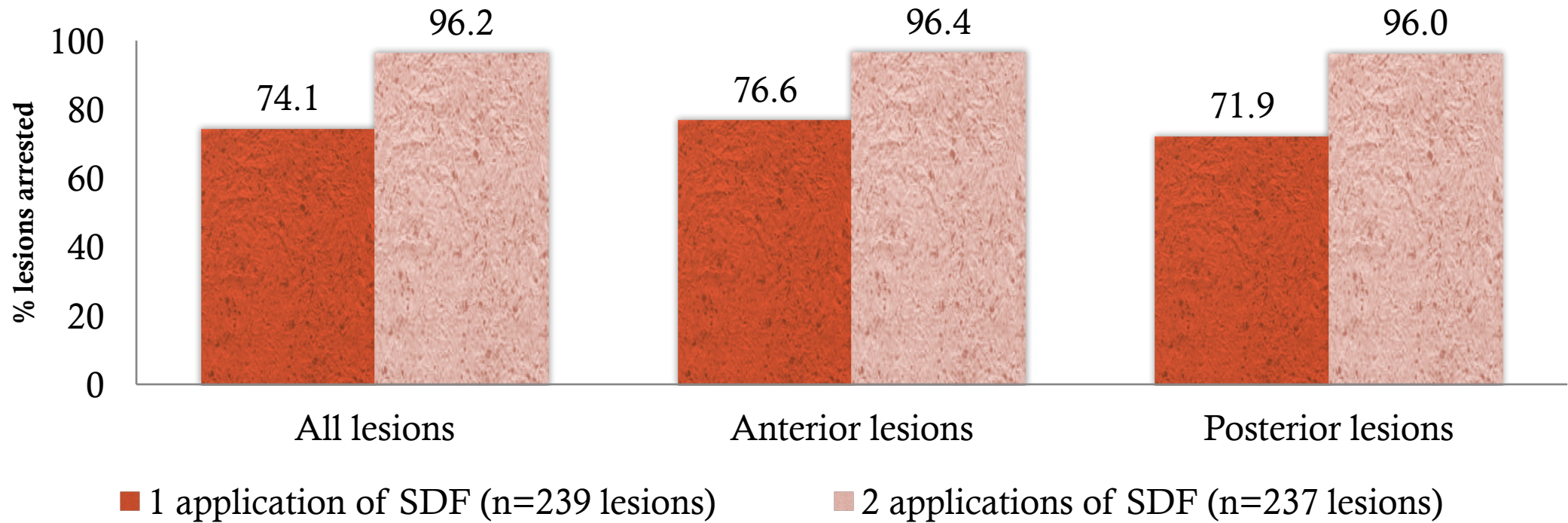
■ Boys ■ Girls



**MEAN AGE (months): 40.2 ± 14.9**

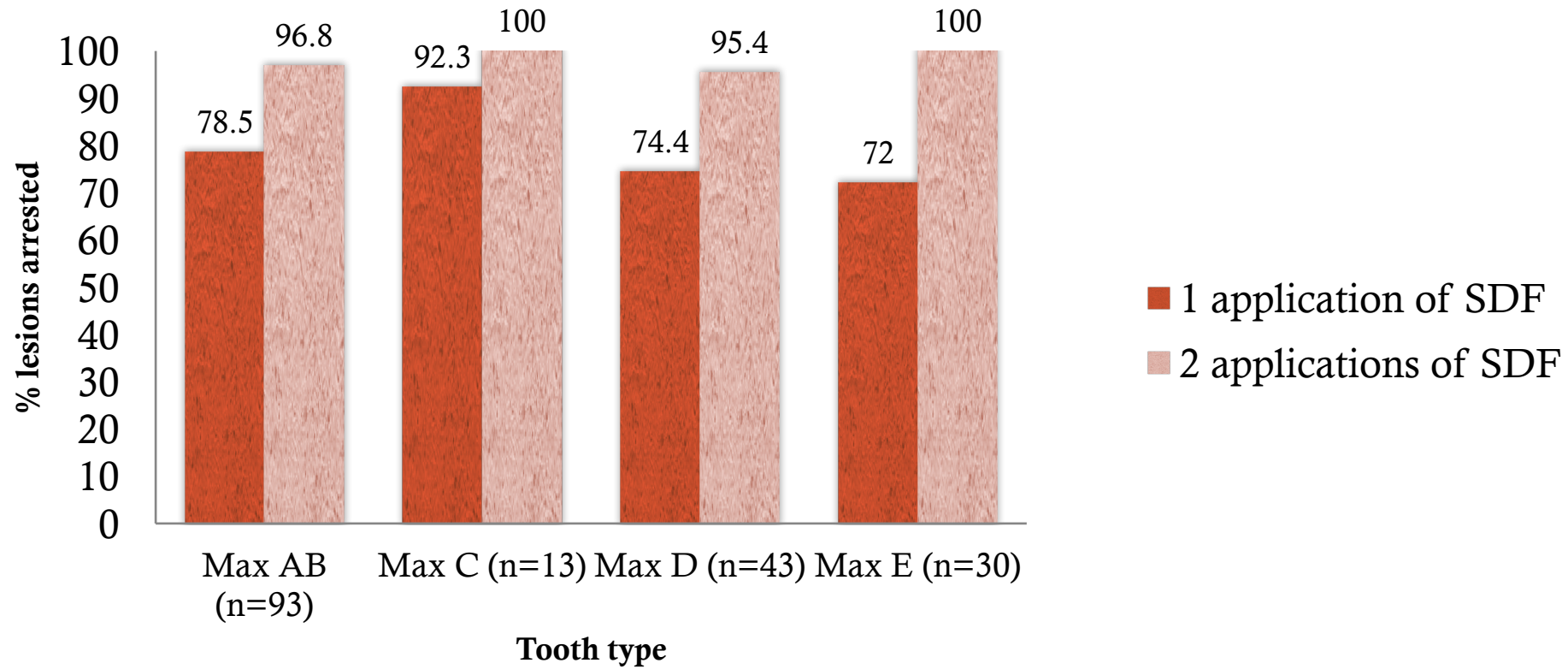
VARIABLE		N (%)
REFUGEE/NEWCOMER	YES	14 (35.0%)
	NO	26 (65.0%)
INSURANCE	YES	12 (30.0%)
	NO	25 (62.5%)
	UNSURE	3 (7.5%)
ETHNICITY	AFRICAN	16 (40.0%)
	ASIAN	17 (42.5%)
	CAUCASIAN	3 (7.5%)
	INDIGENOUS	1 (2.5%)
	OTHER/NO ANSWER	3 (7.5%)

# Results: Arrest Rates

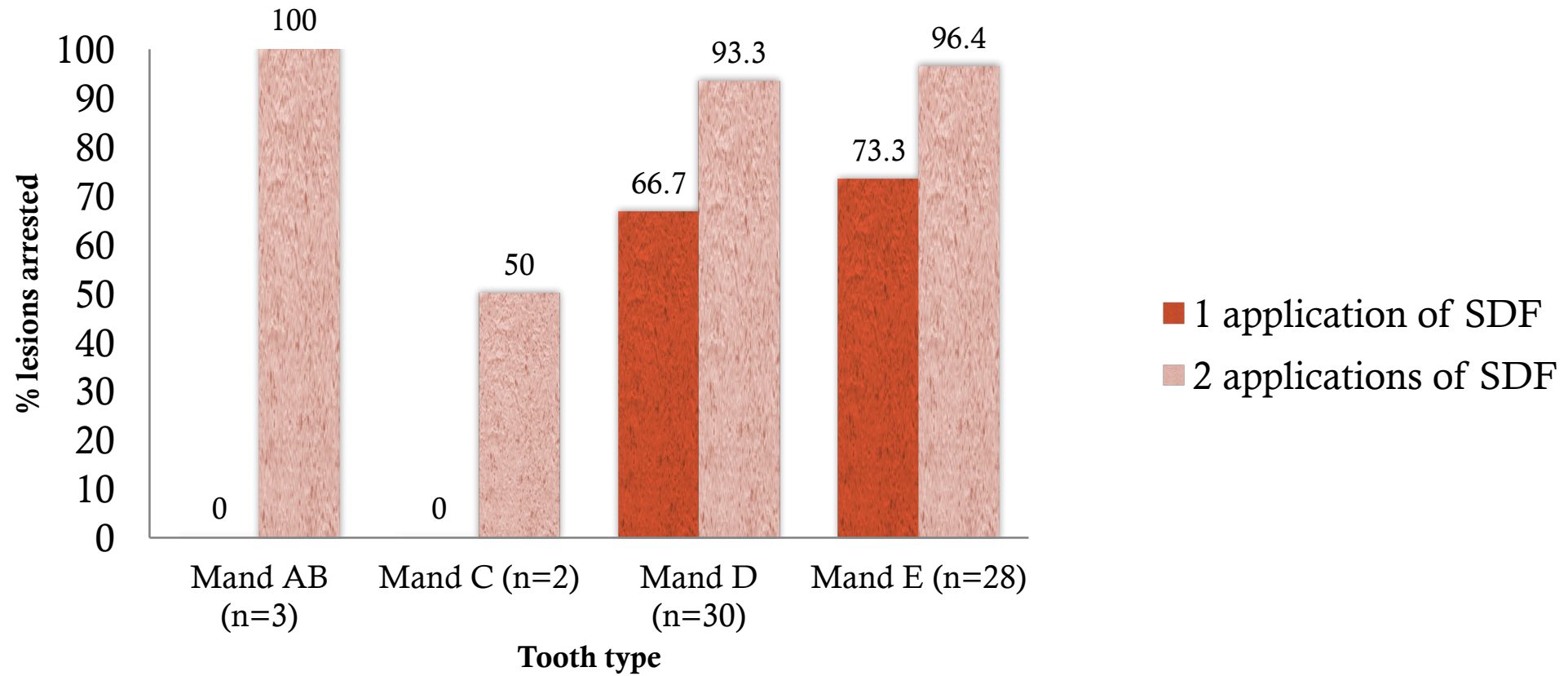




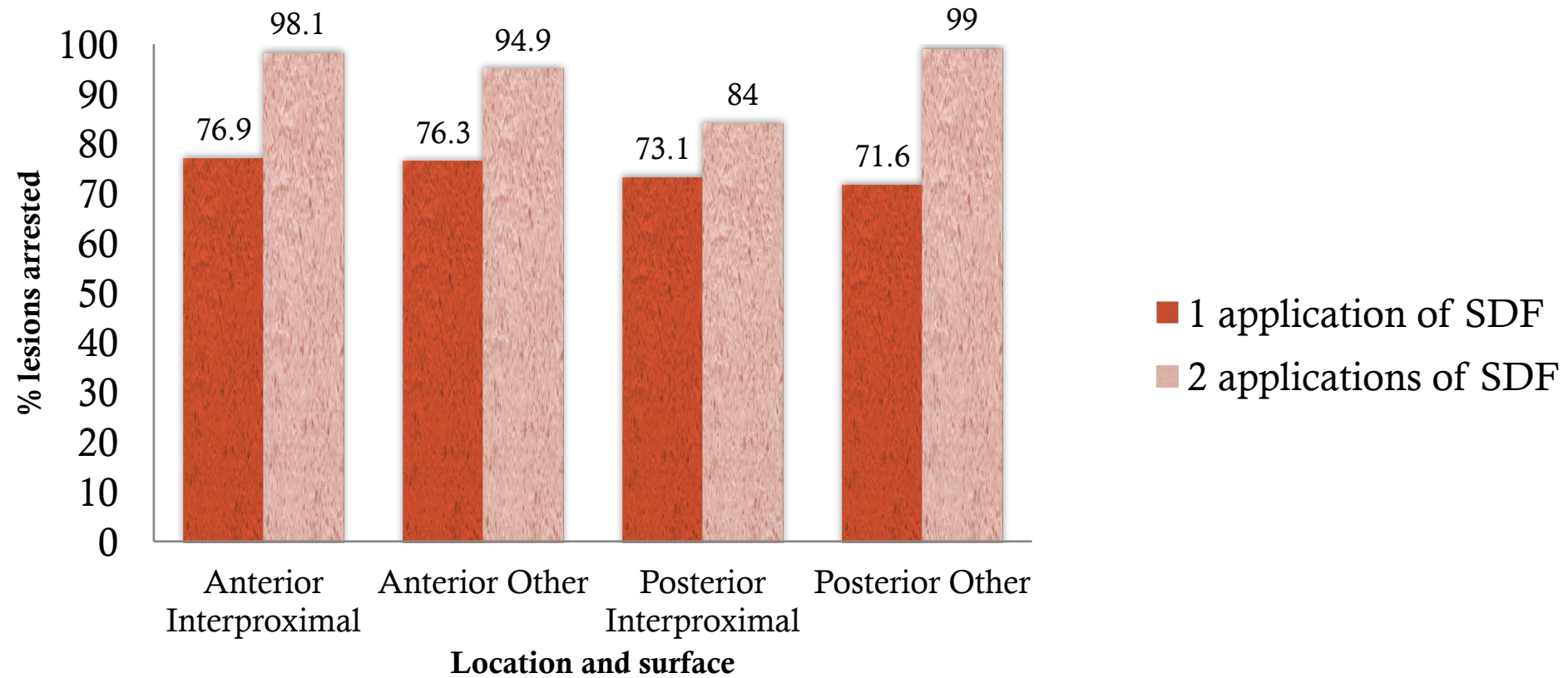
# Results: Arrest Rates of Maxillary Teeth



# Results: Arrest Rates of Mandibular Teeth

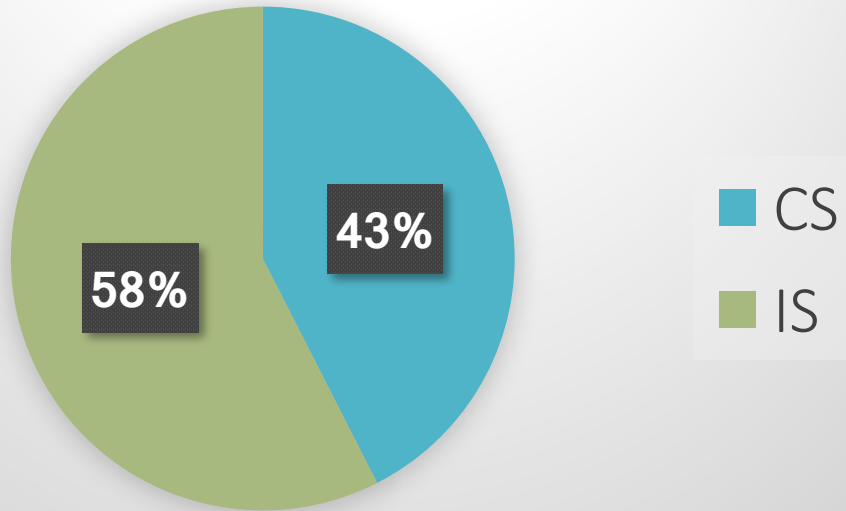


# Results: Arrest Rates by Location and Surface

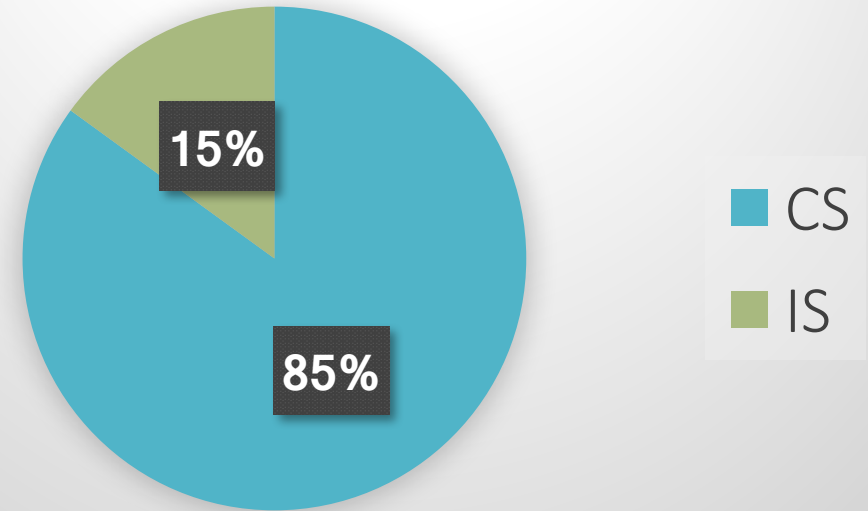


# Results: Child-level Analysis

Second Visit



Third Visit

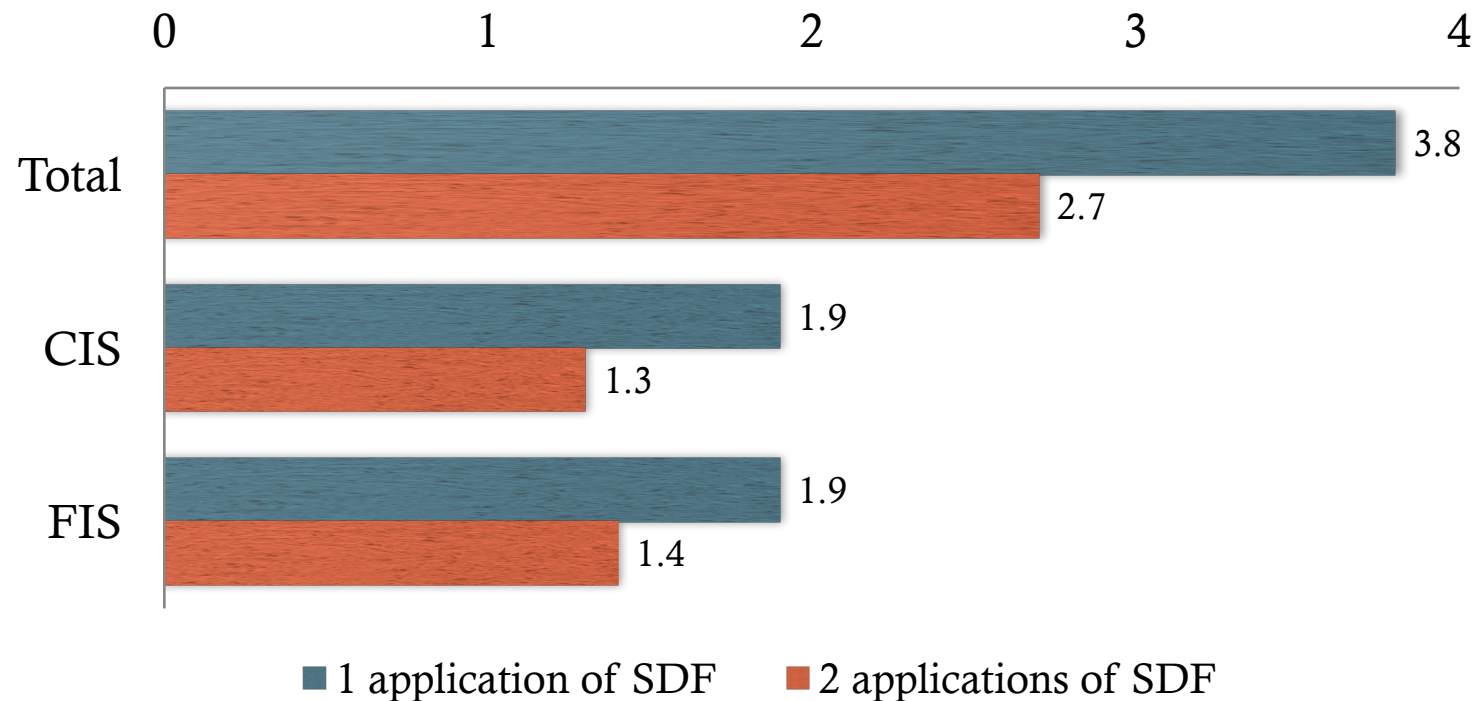


# Results: Child-level Analysis

- Significant association between **frequency of toothbrushing** and arrest at 3<sup>rd</sup> visit
  - Children brushing twice daily more likely to be CS after 2 applications of SDF (p=0.006) as compared to those brushing less than twice daily
- **Baseline dmft** and arrest at 3<sup>rd</sup> visit
  - Children in the CS group had significantly lower baseline dmft of 5.4 compared to 8.8 in the IS group (p=0.048)
- The increase in dmft between 2<sup>nd</sup> and 3<sup>rd</sup> visit was significant (p=0.036) The increase in dmft between 2<sup>nd</sup> and 3<sup>rd</sup> visit was significant (p=0.036)

Baseline dmft (mean ± SD)	2 <sup>nd</sup> visit dmft (mean ± SD)	3 <sup>rd</sup> visit dmft (mean ± SD)
5.9 ± 3.2	6.0 ± 3.3	6.3 ± 3.3

# Results: ECOHIS Scores



- Of the 13 questions, only 2 had an increase in score between the second and third visit:
- “Difficulty drinking” (CIS)
- “Felt guilty” (FIS)



## RESULTS OF COMPARABLE STUDIES

Author, Site, Year	Number of participants, mean age	Study Period	Methods	Arrest Rate
Zhi et al. China, 2012	212 3.8 years	24 months	Group 1: 38% SDF q. 12 months Group 2: 38% SDF q. 6 months	Group 1: 79% Group 2: 91%
Clemens et al. USA, 2017	32 3.6 years	3 months	38% SDF applied 1-2 times	3 week r/c: 98% 3 month r/c: 100%
Fung et al. Hong Kong, 2017	888 3.8 years	30 months	Group 1: 38% SDF q. 12 months Group 2: 38% SDF q. 6 months	Group 1: 66.9% Group 2: 75.7%
Our Study	40 3.5 years	8 months	38% SDF applied at baseline and at 4 months	4 month r/c: 74.1% 8 month r/c: 96.2%

# Discussion

- Lower arrest rates for posterior interproximal lesions is consistent with other studies (Zhi et al., Fung et al.)
  - Increased difficulty in cleansing these surfaces
- Anterior lesions are more readily cleansed due to greater accessibility
- Increased likelihood of food impaction



Photo courtesy of Dr. B. Schroth

# Discussion

- Children with a lower pre-treatment dmft and those who brush twice daily may have greater success
  - Children with higher dmft scores or poor homecare routines may require additional applications of SDF
- New lesions can still develop in children undergoing SDF treatment
  - Results variable in other studies with some having similar results and others observing a significant reduction in the development of new caries lesions (Fung et al., Llodra et al., Lo et al.)
  - No studies have demonstrated an absolute reduction in new caries development
  - Homecare and prevention still need to be emphasized

# Discussion

- OHRQoL was not found to be affected by the level of success of SDF treatment, a finding consistent with another study (Duangthip et al.)
  - Children who had emergent treatment needs were excluded from the study and therefore participants had less extensive dental needs and presumably higher OHRQoL at baseline, making treatment effects less pronounced
- The increase in the parental distress parameter “felt guilty” was also observed in another study (Duangthip et al.)
  - May be explained by the black staining which serves as a daily visual reminder to parents of their child’s past caries experience

# Discussion

- Limitations
  - Lack of baseline ECOHIS
  - Small sample size
  - No control group
  - Lack of a blind observer
  - No radiographs
  - Missing data
- Strengths
  - Longitudinal study
  - Good follow-up (no drop-out)
  - Study sample representative of the population who may benefit the most from SDF treatment



Photo courtesy of Dr. B. Schroth

# Conclusions

1. SDF is an effective strategy for treating ECC and may have a significant role in shifting the paradigm from surgical intervention to disease management
2. Two applications of SDF are more effective than one application and children must be reassessed at regular intervals
3. Children with relatively lower dmft scores and those who brush daily may experience greater success with SDF treatment
4. OHRQoL is not affected by the level of success of SDF treatment and may serve to guide patient selection and differentiate children with lower impacts who may be treated with SDF from those with higher impacts who may require more conventional surgical treatment



# Qualitative Component of SDF Feasibility Study

## Feasibility and acceptability of using silver diamine fluoride to arrest ECC in young children

### Focus group and key informant interview guide

#### Interview Guide

1. Introductions of research team. Anonymous for participants.
2. First name \_\_\_\_\_
3. Number of children: \_\_\_\_\_ # Boys \_\_\_\_\_ #Girls \_\_\_\_\_
4. What do you think about baby teeth?
  - a) **Are baby teeth important? Please explain why you think that.**
5. What did you think when the dentist or dental staff first told you about silver diamine fluoride and that it might be able to stop your child's cavities from growing?
6. What are your thoughts on the silver diamine fluoride liquid that was put on your child's cavities?
  - a) **Is there anything that you were worried about with the treatment?**
7. Has this product changed the way you think about dealing with your child's cavities? If so, how?
8. Were there any good things about having your child's cavities treated with SDF?
9. Did you have any concerns about having your child's cavities treated with silver diamine fluoride?
  - a. How did your child react to the treatment? Were there any specific reactions to their cavities changing colour?
  - b. **How did you feel when you saw the treatment? How did you react to their cavities changing colour?**
10. Do you have any suggestions for how or whether silver diamine fluoride could be used to stop cavities in children?

## Qualitative interviews with parents and caregivers

- Parental and caregiver views on SDF
- Were there good things about your child receiving SDF
- Concerns about child receiving SDF
- Reaction to the colour change

# Characteristics of Participants

- Parents of children under 72 months (5.4% mean age of children).
- Mixed population of new immigrants to Canada representing over 10 distinct countries.
- Parents of 21 children participated.
- 26.4% males/fathers (n=5) and 73.6% females/mothers (n=14).

Variable	Respondents
Number of parents participating	19
Females/Mothers	14 (73.6%)
Males/Fathers	5 (26.4%)
African descent	5 (26.3%)
Asian descent	4 (21%)
European descent	1 (5.2%)
Middle Eastern	5 (26.3%)
North American descent	3 (15.7%)
South American/Latino descent	1 (5.2%)

# Methods

- Semi-structured, in-depth interviews with parents of children who received SDF treatment.
- 21 interviews in total, 2 excluded for poor quality, 19 included.
- Interviews were conducted in person and by phone.
- Interpreter services used for participants with low English capabilities.
- Data was transcribed verbatim and preliminarily analyzed using manual coding.
- Themes represent majority views of all respondents.

# Preliminary Result: Awareness of SDF

All parents learned of SDF as a treatment option from the dentist (in the study).

“He [child] had tooth pain in the back there. And the doctor actually had to remove his tooth that day. We went in... for an emergency dental appointment, he pulled his tooth out. He [doctor] talked to me about the silver treatment because my kids have never been to a dentist before.”

# Preliminary Results: Additional information on SDF

Some were happy to have received additional information and articles to read further about SDF.

“He [dentist] said it is safe. So I trust him. He gave us a few papers to read about it. I read all of those and I think it’s good.”

# Preliminary Results: Acceptance of SDF

Majority were accepting of the treatment because it was recommended by the dentist and they trust the dentist's opinion.

“We never have seen before this kind of treatment. The doctor explained to us and so we were satisfied about his explanation. That's why we'll go with that one.”

It stopped the pain, sensitivity and progression of cavities

“It reduces the cavity [...] when we use SDF on the teeth, after a few minutes, pain stopped”

“It helps actually, preventing infections and stuff like that”

It is non-invasive, does not involve drilling and is painless.

“I don't want to go through like all those extensive procedures”



# Preliminary Results: Concern with staining of cavities

Few parents expressed concern with the black staining depending on whether anterior or posterior teeth were treated. Still many generally prefer SDF to options such as fillings, tooth extractions.

“I would [recommend] if it wasn’t the front teeth. Yeah, I would if they weren't visible.”

“We don’t like that treatment because when my son laughs or smiles, his upper teeth look black and dirty, it doesn't—it's not appropriate at all and the lower teeth are white.”

# Preliminary Results: Children not too concerned with staining of cavities

Parents said their preschool children were not concerned with the black staining of cavities likely because many are too young to care and were happy the pain or sensitivity had stopped. Parents thought it may be embarrassing for school age children.

“Well, it is the third time with fluoride (SDF), she’s happy that, no pain.”

“[my child] is very young, he’s only four years old. He didn't care about that yet. But it will be a big trouble when he goes to school, when he is at the age of going to school.”

# Preliminary Results: Parents would recommend SDF

Most parents said they would recommend the treatment and some had already recommend the treatment to their family members and others.

“I recommend it to the other people. It is a good treatment for the kids because it is painless. Everything is good, that’s why.”

“Yeah, I’d recommend it. You know, everything, like effects, like change, they are there to help, I think I give advice for all my friends to do that.”

# Acknowledgments

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Winnipeg Regional Health Authority  
University of Manitoba, Dr. Gerald Niznick College of Dentistry  
The staff of Access Clinic, Mount Carmel Clinic, Smile Plus Clinic

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- Dr. Schroth's CIHR Embedded Clinician Researcher Salary Award in "improving access to oral health care and oral health care delivery for at-risk young children in Manitoba"
- The Dr. Gerald Niznick College of Dentistry Endowment Fund

# American Academy of Pediatric Dentistry (AAPD) Policy Statement on SDF

## The AAPD:

- Supports the use of SDF as part of an ongoing caries management plan with the aim of optimizing individualized patient care consistent with the goals of a dental home
- Supports third party reimbursement for fees associated with SDF
- Encourages more practice-based research to be conducted on SDF to evaluate its efficacy

## Policy on the Use of Silver Diamine Fluoride for Pediatric Dental Patients

### Originating Council

Council on Clinical Affairs

### Adopted

2017

### Purpose

The American Academy of Pediatric Dentistry (AAPD) recognizes that dental caries continues to be a prevalent and severe disease in children. This policy addresses the use of silver diamine fluoride (SDF) as part of an ongoing caries management plan with the aim of optimizing individualized patient care consistent with the goals of a dental home. The dental profession has viewed dental caries as an acute disease condition requiring surgical debridement, cavity preparation, and mechanical restoration of the tooth. Increasingly, especially for the infant and child population, practitioners are utilizing individually tailored strategies to prevent, arrest, or ameliorate the disease process based on caries risk assessment. One of these strategies employs the application of SDF as an antimicrobial and remineralization agent to arrest active carious dental lesions.

### Methods

This policy is a review of current dental and medical literature and sources of recognized professional expertise and stature, including both the academic and practicing health communities, related to SDF and silver nitrate. In addition, literature searches of PubMed®/MEDLINE and Google Scholar databases were conducted using the terms: diamine silver fluoride and caries, Howe's solution, silver nitrate and caries, and silver diamine fluoride; fields: all; limits: within the last 15 years, humans, English, birth through age 99. One hundred eight articles matched these criteria. Papers for review were chosen from this list and from the references within selected articles. Expert and/or consensus opinion by experienced researchers and clinicians also was considered.

### Background

Treatment of incipient caries usually involves early therapeutic intervention using topical fluoride, and non-surgical restorative techniques like sealants and resin infiltration. The use and outcomes of these techniques have been well-documented and there are current policies and guidelines with recommendations for their use in the practice of dentistry.<sup>1-3</sup> In contrast, treatment of cavitated lesions traditionally requires surgical intervention to remove the diseased tooth structure followed by placement of a restorative material to restore form and function

to the tooth. Barriers to traditional restorative treatment (e.g., behavioral issues due to age and/or limited cooperation, access to care, financial constraints) call for other alternative caries management modalities.

Silver topical products, such as silver nitrate and SDF have been used in Japan for over 40 years to arrest caries and reduce tooth hypersensitivity in primary and permanent teeth. During the past decade, many other countries such as Australia and China have been using this compound with similar success.<sup>4,5</sup> As marketed in the United States, SDF is a 38 percent silver diamine fluoride which is equivalent to five percent fluoride in a colorless liquid, with a pH of 10. The exact mechanism of SDF is not understood. It is theorized that fluoride ions act mainly on the tooth structure, while silver ions, like other heavy metals, are antimicrobial. It also is theorized that SDF reacts with hydroxyapatite in an alkaline environment to form calcium fluoride (CaF<sub>2</sub>) and silver phosphate as major reaction products. CaF<sub>2</sub> provides sufficient fluoride to form fluorapatite which is less soluble than hydroxyapatite in an acidic environment.<sup>6,7</sup> A side effect is the discoloration of demineralized or cavitated surfaces. Patients and parents should be advised regarding the black staining of the lesions associated with the application of SDF. Ideally, prior to the use of SDF, parents should be shown before and after images of teeth treated with SDF. Recently, the Food and Drug Administration approved SDF as a device for reducing tooth sensitivity, and off label use for arresting caries is now permissible and appropriate for patients.<sup>8-12</sup>

Many clinical trials have evaluated the efficacy of SDF on caries arrest and/or prevention,<sup>6, 9-11,13-33</sup> although clinical trials have inherent bias (i.e., because of the staining), the difference between control and treated teeth is obvious to the researcher. However, studies consistently conclude that SDF is indeed more effective for arresting caries<sup>6, 9-11,15,16,18,20-33</sup> than fluoride varnish. SDF reportedly also has approximately 2-3 times more fluoride retained than delivered by sodium fluoride,

### ABBREVIATIONS

AAPD: American Academy of Pediatric Dentistry. CaF<sub>2</sub>: Calcium fluoride. SDF: Silver diamine fluoride.



## RECOMMENDATIONS: CLINICAL PRACTICE GUIDELINE

### Use of Silver Diamine Fluoride for Dental Caries Management in Children and Adolescents, Including Those with Special Health Care Needs

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**Abstract: Background:** This manuscript presents evidence-based guidance on the use of 38 percent silver diamine fluoride (SDF) for dental caries management in children and adolescents, including those with special health care needs. A guideline workgroup formed by the American Academy of Pediatric Dentistry developed guidance and an evidence-based recommendation regarding the application of 38 percent SDF to arrest cavitated caries lesions in primary teeth. **Types of studies reviewed:** The basis of the guideline's recommendation is evidence from an existing systematic review "Clinical trials of silver diamine fluoride in arresting caries among children: A systematic review." (JDR Clin Transl Res 2016;1[3]:201-10). A systematic search was conducted in PubMed®/MEDLINE, Embase®, Cochrane Central Register of Controlled Trials, and gray literature databases to identify randomized controlled trials and systematic reviews reporting on the effect of silver diamine fluoride and address peripheral issues such as adverse effects and cost. The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach was used to assess the quality of the evidence and the evidence-to-decision framework was employed to formulate a recommendation. **Results:** The panel made a conditional recommendation regarding the use of 38 percent SDF for the arrest of cavitated caries lesions in primary teeth as part of a comprehensive caries management program. After taking into consideration the low cost of the treatment and the disease burden of caries, panel members were confident that the benefits of SDF application in the target populations outweigh its possible undesirable effects. Per GRADE, this is a conditional recommendation based on low-quality evidence. **Conclusions and practical implications:** The guideline intends to inform the clinical practices involving the application of 38 percent SDF to enhance dental caries management outcomes in children and adolescents, including those with special health care needs. These recommended practices are based upon the best available evidence to-date. A 38 percent SDF protocol is included in Appendix II. (Pediatr Dent 2017;39(5):E135-E145)

**KEYWORDS:** SILVER DIAMINE FLUORIDE, CLINICAL RECOMMENDATIONS, GUIDELINE, ANTI-INFECTIVE AGENTS, CARIOSTATIC AGENTS, SILVER COMPOUNDS, CARIES, TOPICAL FLUORIDES





**Table 3. SUMMARY OF FINDINGS: EVIDENCE FOR THE RELATIVE AND ABSOLUTE EFFICACY OF SDF APPLICATION COMPARED TO NO SDF FOR THE ARREST OF CAVITATED CARIES LESIONS ON PRIMARY TEETH\***

**Patient or population:** Children and adolescents with cavitated caries lesions on primary teeth

**Intervention:** SDF (various periodicities)

**Comparison:** No SDF (various controls, including active agents and treatment)

**Outcome:** Caries arrest in primary teeth

Follow-up time; n surfaces (studies)	Relative efficacy, RR (95% CI)	Absolute estimates, % arrested lesions (95% CI) <sup>Ω</sup>		Quality assessment
		No SDF (other active controls or no treatment)	SDF	
24 months; 746 surfaces (2 RCTs: Yee et al., 2009 & Zhi et al., 2012) <sup>ν</sup>	RR 1.45 (0.79 to 2.66)	47.9% (3.8 to 95.6) <sup>A</sup>	68.0% (9.7 to 97.7)	⊕○○○ VERY LOW <sup>a,b,c</sup>
≥ 24 months; 3313 surfaces (3 RCTs: Llodra et al., 2005, Yee et al., 2009 & Zhi et al., 2012, 1 CCT: Chu et al., 2002) <sup>§</sup>	RR 1.42 (1.17 to 1.72)	49.6% (28.8 to 70.5) <sup>C</sup>	72.4% (48.0 to 88.1)	⊕○○○ VERY LOW <sup>a,d,e</sup>
≥ 30 months; 2567 surfaces (1 CCT: Chu et al., 2002 & 1 RCT: Llodra et al., 2005.) <sup>Ξ</sup>	RR 1.48 (1.32 to 1.66)	50.8% (32.5 to 69.0) <sup>B</sup>	76.4% (52.1 to 90.6)	⊕⊕○○ LOW <sup>a,b</sup>
semi-annual application ≥ 24 months; 1784 surfaces (2 RCTs: Llodra et al., 2005 & Zhi et al., 2012)	RR 1.25 (0.99 to 1.58)	72.4 % (47.2 to 88.5) <sup>A</sup>	87.7% (80.9 to 92.4)	⊕○○○ VERY LOW <sup>a,d,e</sup>

CCT= Controlled clinical trials; CI= Confidence interval; RCTs= Randomized control trials; RR= Relative risks.

\* Rates of arrest on untreated groups may seem unusually high, and this may be due to background fluoride exposure. In one of the trials<sup>7</sup>, all participants (i.e., both the SDF-treated and control children) received 0.2 percent NaF rinse every other week in school, while in other trials, children were either given fluoride toothpaste<sup>13</sup> or reported use of fluoride toothpaste<sup>9</sup>.

<sup>ν</sup> Yee is once a year application of SDF, and Zhi is once a year vs. twice a year.

<sup>§</sup> Chu is once a year application of SDF, Llodra is twice a year, Yee is once a year, and Zhi is once a year vs. twice a year.

<sup>Ξ</sup> Chu is once a year application of SDF, Llodra is twice a year

<sup>Ω</sup> The pooled effect estimates and confidence intervals for the relative risk and absolute percentages were derived from random effect modeling.

<sup>A</sup> Comparisons included glass ionomer and no treatment.

<sup>B</sup> Comparisons included no treatment.

<sup>C</sup> Comparisons included both A and B.

<sup>a</sup> At least one domain had 'unclear' risk of bias assessment.

<sup>b</sup> High heterogeneity.

<sup>c</sup> Wide confidence interval of the relative risk.

<sup>d</sup> Very high heterogeneity.

<sup>e</sup> Wide confidence interval.



## Chairside Guide: Silver Diamine Fluoride in the Management of Dental Caries Lesions\*

Dental caries affects about one out of four children aged 2-5 years.<sup>1</sup> Silver diamine fluoride (SDF), recently approved for use in the United States, has been shown to be efficacious in arresting caries lesions.<sup>2,3</sup> It is a valuable therapy which may be included as part of a caries management plan for patients. Caries lesions treated with SDF usually turn black and hard. Stopping the caries process in all targeted lesions may take several applications of SDF, and reapplication may be necessary to sustain arrest.



Active cavitated caries lesions before application of SDF



SDF-treated lesions with temporary gingival staining

### Case selection for application of silver diamine fluoride

Patients who may benefit from SDF include those:

- With high caries risk who have active cavitated caries lesions in anterior or posterior teeth;
- Presenting with behavioral or medical management challenges and cavitated caries lesions;
- With multiple cavitated caries lesions that may not all be treated in one visit;
- With dental caries lesions that are difficult to treat; and
- Without access to or with difficulty accessing dental care.

Criteria for tooth selection include:

- No clinical signs of pulpal inflammation or reports of unsolicited/spontaneous pain.
- Cavitated caries lesions that are not encroaching on the pulp. If possible, radiographs should be taken to assess depth of caries lesions.
- Cavitated caries lesions on any surface as long as they are accessible with a brush for applying SDF. (Orthodontic separators may be used to help gain access to proximal lesions.)

SDF can be used prior to restoration placement and as part of caries control therapy.<sup>4</sup> Informed consent, particularly highlighting expected staining of treated lesions, potential staining of skin and clothes, and need for reapplication for disease control, is recommended.

### Clinical application of silver diamine fluoride

- Remove gross debris from cavitation to allow better SDF contact with denatured dentin.
- Carious dentin excavation prior to SDF application is not necessary. As excavation may reduce proportion of arrested caries lesions that become black, it may be considered for esthetic purposes.

- A protective coating may be applied to the lips and skin to prevent a temporary henna-appearing tattoo that can occur if soft tissues come into contact with SDF.
- Isolate areas to be treated with cotton rolls or other isolation methods. If applying cocoa butter or any other product to protect surrounding gingival tissues, use care to not inadvertently coat the surfaces of the caries lesions.
- Caution should be taken when applying SDF on primary teeth adjacent to permanent anterior teeth that may have non-cavitated (white spot) lesions to avoid inadvertent staining.
- Careful application with a microbrush should be adequate to prevent intraoral and extraoral soft tissue exposure. No more than one drop of SDF should be used for the entire appointment.
- Dry lesion with gentle flow of compressed air.
- Bend micro sponge brush. Dip brush into SDF and dab on the side of the plastic dappen dish to remove excess liquid before application. Apply SDF directly to only the affected tooth surface. Remove excess SDF with gauze, cotton roll, or cotton pellet to minimize systemic absorption.
- Application time should be at least one minute if possible. (Application time likely will be shorter in very young and difficult to manage patients. When using shorter application periods, monitor carefully at post-op and re-care to evaluate arrest and consider re-application.)
- Apply gentle flow of compressed air until medicament is dry. Try to keep isolated for as long as three minutes.
- The entire dentition may be treated after SDF treatment with five percent sodium fluoride varnish to help prevent caries on the teeth and sites not treated with SDF.

\* Refer to AAPD Recommendations: *Clinical practice guideline on the use of silver diamine fluoride for dental caries management in children and adolescents including those with special health care needs.* (<http://www.aapd.org/policies/>)

# AAPD Case selection for SDF

Patients who may benefit from SDF include those:

- With high caries risk who have active cavitated caries lesions in anterior or posterior teeth;
- Presenting with behavioral or medical management challenges and cavitated caries lesions;
- With multiple cavitated caries lesions that may not all be treated in one visit;
- With dental caries lesions that are difficult to treat; and
- Without access to or with difficulty accessing dental care.

# AAPD Case Selection

## Criteria for tooth selection include:

- No clinical signs of pulpal inflammation or reports of unsolicited/spontaneous pain.
- Cavitated caries lesions that are not encroaching on the pulp. If possible, radiographs should be taken to assess depth of caries lesions.
- Cavitated caries lesions on any surface as long as they are accessible with a brush for applying SDF. (Orthodontic separators may be used to help gain access to proximal lesions.)



SDF can be used prior to restoration placement and as part of caries control therapy.<sup>4</sup> Informed consent, particularly high-lighting expected staining of treated lesions, potential staining of skin and clothes, and need for reapplication for disease control, is recommended.



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### UCSF Protocol for Caries Arrest Using Silver Diamine Fluoride: Rationale, Indications, and Consent

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#### Abstract

The Food and Drug Administration recently cleared silver diamine fluoride for reducing tooth sensitivity. Clinical trials document arrest and prevention of dental caries by silver diamine fluoride; this off-label use is now permissible and appropriate under U.S. law. A CDT code was approved for caries arresting medicaments for 2016 to facilitate documentation and billing. We present a systematic review, clinical indications, clinical protocol, and consent procedure to guide application for caries arrest treatment.

#### Introduction

Until now, no option for the treatment of dental caries in the United States besides restorative dentistry has shown substantial efficacy.<sup>1</sup> Silver diamine fluoride is an inexpensive topical medicament used extensively in other countries to treat dental caries across the age spectrum. No other intervention approaches the ease of application and efficacy. Multiple randomized clinical trials – with hundreds of patients each – support use for caries treatment, thus substantiating an intervention that addresses an unmet need in American dentistry. In August 2014 the Food and Drug Administration (FDA) cleared the first silver diamine fluoride product for market, and as of April 2015 that product is available.

Since approval in Japan over 80 years ago,<sup>2</sup> more than two million containers have been sold. The silver acts as an antimicrobial, the fluoride promotes remineralization, and the ammonia stabilizes high concentrations in solution.<sup>3</sup>

Because silver diamine fluoride is new to American dentistry and dental education, there is a need for a standardized guideline, protocol, and consent. The UCSF School of Dentistry Paradigm Shift Committee assembled a subcommittee with the following goals: Use available evidence to: 1. Develop a list of clinical indications; 2. Define a protocol that maximized safety and efficacy, and minimized inadvertent staining of clinical facilities; and 3. Build an informed consent document at the 8<sup>th</sup> grade reading level. We conducted a systematic review, inquired of authors of published clinical and *in vitro* studies about details

#### Silver Diamine Fluoride (SDF)

##### UCSF Protocol for Arresting Dental Carious Lesions or Treating Tooth Sensitivity

**Material:** "Advantage Silver Arrest™" (38% SDF, purified water) from Elevate Oral Care. Shelf life: 3 years unopened. Do not refrigerate. Avoid freezing or extreme heat.

#### Indications:

1. Extreme caries risk (Xerostomia or Severe Early Childhood Caries).
2. Treatment challenged by behavioral or medical management.
3. Patients with carious lesions that may not all be treated in one visit.
4. Difficult to treat dental carious lesions.
5. Patients without access to dental care.

**Maximum dose:** 25 uL (1 drop) / 10kg per treatment visit.

**SDF Contraindication:** Silver allergy

**SDF Relative Contraindications:** Ulcerative gingivitis, Stomatitis.

**SSKI Contraindications:** Pregnancy, Breastfeeding.

#### Considerations:

- Decayed dentin will darken as the caries lesions arrest. Most will be dark brown or black
- SDF can stain the skin, which will clear in 2-3 weeks without treatment.
- SDF can permanently stain operator surfaces and clothes.
- A control restoration (e.g. GI via ART or other material) may be considered after SDF treatment.
- Saturated Solution of Potassium Iodide (SSKI, Lugol's Solution, various sources) can be used after SDF to decrease color changes.
- Re-application is usually recommended, biannually until the cavity is restored or arrested or the tooth exfoliates.

#### Procedure:

1. Plastic-lined cover for counter, plastic-lined bib for patient.
2. Standard Personal Protective Equipment (PPE) for provider and patient.
3. 1 drop of SDF into the deep end of a plastic dappen dish.  
(also obtain 1 drop of SSKI in a separate dappen dish if selected)
4. Remove bulk saliva with saliva ejector.
5. Isolate tongue and cheek from affected teeth with "2x2" gauze or cotton rolls.
6. If near the gingiva, consider applying petroleum jelly with a cotton applicator for safety.
7. Dry affected tooth surfaces with triple syringe, or if not feasible dry with cotton.
8. Bend microspoon, immerse into SDF, remove excess on side of dappen dish.
9. Apply directly onto the affected tooth surface(s) with microspoon.
10. Allow SDF to absorb for up to 1 minute if reasonable, then remove excess with gauze or cotton roll.  
(If using SSKI, apply with a different microspoon. Repeat 1-3 times until no further white precipitates are observed. Wait 5-10 seconds between applications. Remove excess with cotton.)
11. Rinse with water.
12. Place gloves, cotton, and microbrushes into plastic waste bags.

**Figure 3.**  
Clinical protocol for the UCSF dental clinics.



# Winnipeg Regional Health Authority Protocol for SDF Case Selection

SDF may be helpful in managing caries among individuals who:

- Are at high caries risk and have active cavitated caries lesions in anterior or posterior teeth, whether coronal or root;
- Present with behavioural or medical management challenges and caries lesions;
- Have multiple caries lesions that may not all be treated in one visit;
- Have dental caries lesions that are difficult to treat with traditional invasive restorations; and
- Have no access/limited access or difficulty accessing dental care.

## Clinical Guideline for the Use of Silver Diamine Fluoride (SDF) in the Management of Caries Lesions

Contact: Dr. Robert J Schroth [robert.schroth@umanitoba.ca](mailto:robert.schroth@umanitoba.ca)

The following guideline provides our interpretation of current best evidence and practice for the use of SDF in managing caries lesions<sup>1-4</sup> and a perspective not emphasized in other existing guidelines.

### **Background:**

For treatment purposes, historically caries is often considered a single disease. The treatment for different age groups have been to restore caries lesions to restore the appearance and functionality of the tooth. In most cases, this required an invasive preparation of the area to be restored, followed by filling the cavity with a durable material that in most circumstances is expected to last for decades. In permanent dentition, this approach has been so successful that one internationally known expert has recommended that the DMFT index is not appropriate as a measure of level of dental disease because the majority of filled teeth are functionally sound.<sup>5</sup>

A one-size fits all approach may not be appropriate for SDF. Distinct types of caries require different treatment considerations:

1. Caries in the primary dentition: These teeth typically exfoliate 5-10 years after eruption, and often will exfoliate within only a few years after development of a carious lesion. There is no need for a treatment that will last for decades, and thus the goals become: 1) keep the child out of pain and 2) maintain functionality of the tooth until exfoliation, including ensuring the tooth stays in the mouth as a space-holder for the subsequent permanent dentition.
2. Permanent dentition: There is a need to eliminate pain, and to maintain form and function for decades.
3. Root caries: These lesions are most common in older adults, and traditional invasive restorations are both traumatic and often logistically difficult for individuals who cannot travel to the dental clinic.

In our opinion, the above considerations lead us to the conclusion that in many cases of categories 1 and 3 above, SDF may often be the only treatment needed for the affected tooth. SDF may be a suitable alternative treatment for children with primary dentition, elderly clients or adults with physical or mental challenges. The ease of application, less invasive nature, effective and short procedure time make it an alternative in some situations. In contrast, in most instances of caries in the permanent dentition, SDF may not be considered a definitive treatment, though as explained below, there are certainly situations in which it may be entirely appropriate for a temporary arrest of disease. These considerations are reflected in the guidelines below.

### **Case Selection<sup>1</sup>:**

SDF may be helpful in managing caries among individuals who:

- Are at high caries risk and have active cavitated caries lesions in anterior or posterior teeth, whether coronal or root;
- Present with behavioural or medical management challenges and caries lesions;
- Have multiple caries lesions that may not all be treated in one visit;
- Have dental caries lesions that are difficult to treat with traditional invasive restorations; and
- Have no access/limited access or difficulty accessing dental care.

Modified from:

American Academy of Pediatric Dentistry Chairside Guide: Silver diamine fluoride in the management of dental caries lesions.  
USCF Protocol for caries arrest using silver diamine fluoride: rationale, indications, and consent.



April 2018



Winnipeg Regional  
Health Authority  
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santé de Winnipeg  
À l'écoute de notre santé

# Winnipeg Regional Health Authority Protocol for SDF

## Tooth Selection for Treatment with SDF (please carefully consider before managing caries with SDF)

- Teeth to be treated should have no clinical signs of pulpal inflammation or reports of unsolicited/spontaneous pain.
- Avoid applying SDF to very deep cavitated caries lesions that are encroaching on the pulp. If possible, radiographs should be taken to assess the depth of the caries lesion(s).
- Cavitated caries lesions on any surface can receive SDF as long as these lesions are accessible with a brush for applying SDF. Orthodontic separators may be used to help gain access to proximal lesions.
- SDF can be integrated into restorative procedures and be used prior to restoration placement, and as part of caries control therapy.<sup>4</sup> It can also be placed on visible incipencies on proximal surfaces of adjacent teeth when they become visible during restorative procedures.



# Obtain Informed Consent from Patient (if adult) or Parent/Guardian (if child)

- Clinic staff must explain the benefits of SDF vs. traditional restorative or surgical approaches (fillings, crowns, extractions, etc.).
- Informed consent is recommended, particularly highlighting the expected staining of treated caries lesions, skin and clothes, and the need for reapplication to sustain the arrest of caries.
- Complete the SDF Consent Form.



# Winnipeg Regional Health Authority Protocol for SDF

## Clinical Application of Silver Diamine Fluoride – Step by Step

- The patient should wear a plastic-lined bib and protective eyewear.
- The dental provider is to wear standard Personal Protective Equipment (PPE).
- Dispense SDF into a plastic well/dappen dish. Do not dispense SDF into a glass well/dappen dish. One (1) drop of SDF is generally sufficient to treat 4 or 5 lesions. Do not dispense more than 2 drops (~1 drop/10 kg per treatment visit).
- Apply a protective coating of petroleum jelly (i.e. Vaseline) or cocoa butter to the lips and skin around the mouth to prevent a temporary henna-like tattoo that can occur if SDF comes in contact with soft tissues.
- Remove gross debris from cavitated lesion to allow better SDF contact with the denatured dentin.





# Clinical Application of Silver Diamine Fluoride – Step by Step

- Measure the size of the caries lesion (in mm) to be treated with a probe, assess the hardness of the lesion with a ball ended probe (e.g. soft, moderate, hard), and assess the colour of the lesion (e.g., yellow, brown, black). These are important factors to consider in order to assist in future determination that the treated lesions have actually arrested.

Figure 2. Co-Investigator Reminder Cards Exhibiting Examples of ICDAS and Color Categories



- Excavation of decayed dentin prior to SDF application is not necessary. However, since excavation may reduce the proportion of the arrested caries lesions that become black, it may be considered for esthetic purposes.
- Isolate the caries lesions to be treated by SDF with cotton rolls or gauze, or other isolation methods. If applying any other product to protect the surrounding tissue, use care to not inadvertently coat the surfaces of the caries lesions that are to be treated with SDF.



# Clinical Application of Silver Diamine Fluoride – Step by Step

- Be careful to avoid getting SDF on non-cavitated/white spot lesions on permanent anterior teeth that are adjacent to primary teeth you are treating with SDF, as this may inadvertently stain these areas on permanent teeth. Consider applying fluoride varnish to these non-cavitated white spots on permanent anterior teeth prior to applying SDF to adjacent teeth to minimize this risk.
- Dry the lesion with gentle flow of air or with gauze. (The air/water syringe may not be well tolerated by very young children or those who are anxious/phobic. An alternative to the air/water syringe is to isolate the area with cotton rolls, drying the caries lesion with a cotton pellet).
- Use a micro-brush to prevent intraoral and extra-oral soft tissue exposure.
- Dip the micro-brush into the well/dappen dish containing the SDF and then apply the SDF directly to the caries lesion to be treated. Keep gauze adjacent to the tooth to prevent the SDF from touching soft tissues and minimize systemic absorption. Allow the SDF to remain on the caries lesion for a minimum of 1 minute.



# Clinical Application of Silver Diamine Fluoride – Step by Step

- This maybe shorter in very young and difficult to manage patients. When using shorter application periods, monitor carefully at post-op and re-care to evaluate arrest and consider re-application.
- Rinse the treated area(s) with water. (An alternative for anxious/phobic young children is to dry off any remaining SDF with a cotton pellet).
- Lastly, 5% sodium fluoride varnish may be applied to the entire dentition, including the SDF-treated area(s) as an additional preventive step.
- Follow-up can be scheduled at 2-4 weeks after initial treatment to check the arrest of the lesions treated. However, follow-up after 3-4 months appears to be acceptable. The American Dental Association is now recommending SDF twice a year for cavitated caries lesions on coronal surfaces in primary and permanent teeth.



# Winnipeg Regional Health Authority Protocol for SDF

## Follow-up

- Please be sure to assess each treated caries lesion at the follow-up visit, measuring size (in mm), and assessing hardness (e.g. soft, moderate, hard), and colour change (e.g., yellow, brown, black).
- Reapplication of SDF may be indicated if the treated lesions do not appear arrested (dark and hard). Additional SDF can be applied at recall appointments as needed, based on the colour and hardness of the lesion or evidence of lesion progression.
- Caries lesions can be restored after treatment with SDF, though as noted in the Introduction above, for caries in the primary dentition and root caries, invasive restorations are usually not needed. However, many dentists who are using SDF for caries in primary teeth place glass ionomer materials over the SDF treated lesion to restore form, function, and esthetics.
- When lesions are not restored after SDF therapy, bi-annual (every 6 months) re-application shows increased caries arrest rate versus a single application.



# Clinical Application of Silver Diamine Fluoride – Step by Step

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# Is there a Code for SDF Application?

- The Canadian Dental Association suggests providers use 13601
- 13601 is “Topical application to hard tissue of an antimicrobial or remineralization agent”
- 1 unit of time (i.e., 15 minutes)
- MDA fee \$38.00 per one unit of time

# Example of a Decision Tree for SDF in Clinical Practice

COMMENTARY



## Silver Diamine Fluoride: A Clinical Perspective From a Pediatric Dentist

Gary D. Sabbadini, DDS

**ABSTRACT** This commentary reviews how silver diamine fluoride (SDF) has been incorporated into the author's pediatric dental office and the decision-making process for its use.

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*Conflict of Interest Disclosure:* None reported.

**S**ilver diamine fluoride (SDF) is one of the hottest topics in dentistry. When an article in *The New York Times* entitled "A Cavity-Fighting Liquid Lets Kids Avoid Dentists' Drills"<sup>1</sup> was published on July 11, 2016, my office began receiving phone calls and emails from all over the country asking about this "new" treatment. While this article certainly captivated many around the country and gave some people hope that they or their children would no longer be required to have their teeth "drilled," it may have caused more confusion for the public and for the dental professionals who care for their oral health.

The purpose of this article is not to describe how SDF works or propose a protocol for its use. Many articles have been written for this purpose including two in the *Journal of the California Dental Association*: "Back to the Future: The Medical Management of Caries Introduction" by Steve Duffin, DDS,<sup>2</sup> and "UCSF Protocol for Caries Arrest Using Silver Diamine Fluoride: Rationale, Indications and Consent" by Jeremy A. Horst, DDS, PhD, et al.<sup>3</sup> This article explains how SDF has been incorporated into my practice and the thought process behind its use.

I have what I consider to be a fairly typical pediatric dental practice. I am a solo practitioner in a working-class area. My practice has a diverse mix of children and young adults of varying ethnicities and socioeconomic backgrounds. Many of my patients have moderate to extensive tooth decay. When I see these patients, I begin to go through a decision-making process on the treatment options taking into account factors such as their age, cooperation level, health, access to care and/or financial constraints (**FIGURE**).

For cooperative children with carious lesions, I will typically recommend that treatment be completed utilizing nitrous oxide/oxygen. Nitrous oxide has the following benefits: anxiolysis, mild analgesia, helps block the dental odors and shields the passing of the dental

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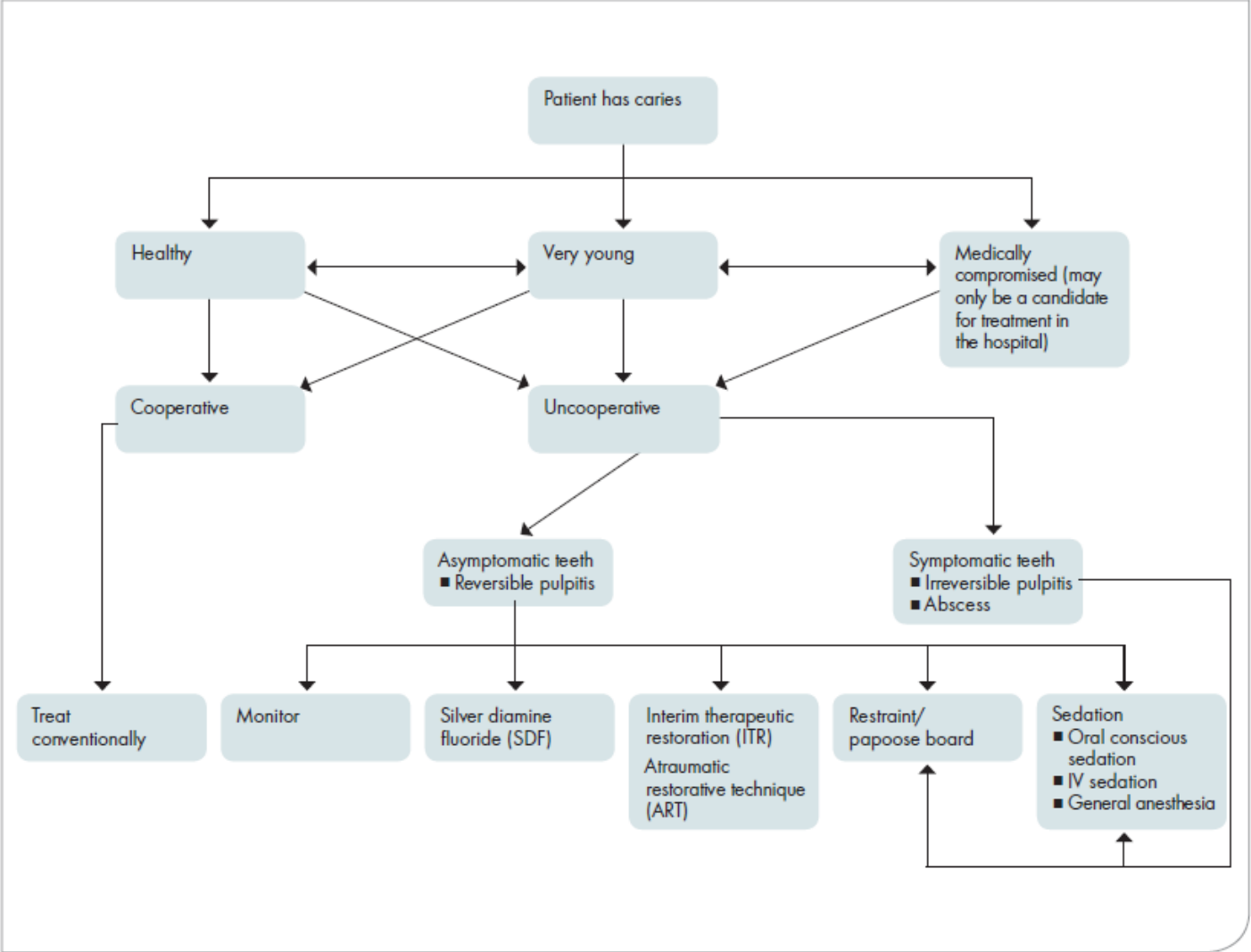


FIGURE. Silver diamine fluoride decision-making tree.



# American Dental Association – How To Apply SDF (Guidelines on Non-Restorative Management of Caries Lesions)

- <https://www.youtube.com/watch?v=a0HH7GifdM4&feature=youtu.be>

# Thank you!

Questions?

# Different Strengths of SDF

## JADA+ CONTENT

This review does not in any way substitute for professional advice and should not be regarded as clinical guidance. As always, any evidence should be carefully considered by clinician and patient to ensure that in their views, all potentially desirable consequences outweigh all potentially undesirable consequences.

## JADA+ CLINICAL SCANS

Romina Brignardello-Petersen, DDS, MSc, PhD

### 37% SILVER DIAMINE FLUORIDE IS MORE EFFECTIVE THAN 12% SILVER DIAMINE FLUORIDE IN ARRESTING CARIES IN THE PRIMARY DENTITION

Fung MHT, Duangthip D, Wong MCM, Lo ECM, Chu CH. Randomized clinical trial of 12% and 38% silver diamine fluoride treatment [published online ahead of print August 1, 2017]. *J Dent Res*. <https://doi.org/10.1177/0022034517728496>.

**Key words.** *Pediatrics*; caries arrest; dental caries; early childhood caries; primary teeth; silver compounds; randomized clinical trial.

**Clinical relevance.** Silver diamine fluoride (SDF) is commonly used to arrest caries in the primary dentition. When providing this treatment, clinicians should use the concentration and application frequency that are likely to have the most benefits.

**Study summary.** The researchers conducted a randomized clinical trial to compare the effects of different concentrations and application frequencies of SDF in arresting caries in primary teeth. They enrolled 888 children\* and assigned them to receive 12% SDF every 12 months (SDF1), 12% SDF every 6 months (SDF2), 38% SDF every 12 months (SDF3), or 38% SDF every 6 months (SDF4). After 30 months, the proportion of surfaces in which caries were arrested was 55% in SDF1, 59% in SDF2, 67% in SDF3, and 76% in SDF4. When the researchers accounted for factors that were associated with caries arrest,† they found that lesions that received 38% SDF had 2 times the odds of experiencing caries arrest than those that received 12% SDF.‡ The frequency of application was not associated with caries arrest.§ The effect of SDF applied annually was associated with oral hygiene, with children with a high visual plaque index¶ score having 0.59 times the odds¶ of experiencing caries arrest than those who had an average visual plaque index score.\*\*

**Strengths and limitations.** This randomized clinical trial had a low risk of bias, and its results are trustworthy. The researchers used appropriate methods at the beginning, during, and after the study. In addition, their data analysis was well done, and the detailed reporting of results provides all the information necessary to determine how useful this study is in making clinical decisions. Although approximately 11% of children were lost to follow-up, according to the information provided by the researchers there is no reason to believe that this may have had an important effect on the results. This study provides evidence that a higher concentration of SDF is more effective in arresting caries than a lower concentration. In addition, it provides evidence that the frequency of SDF application does not affect this outcome. The finding of oral hygiene influencing the results must be interpreted with caution, since there was no indication that this subgroup analysis based on hygiene was planned in advance. In addition, the influence of oral hygiene was not observed in children who received SDF semi annually, which makes us less confident about oral hygiene's influence. Finally, on the basis of the characteristics of the included children, these results are likely to be applicable to most settings. ■

<https://doi.org/10.1016/j.ada.2017.09.03>

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**Disclosure.** Dr. Brignardello-Petersen did not report any disclosures.

\* 42% female; mean (standard deviation [SD]) age, 3.8 (0.6); mean (SE) decayed, missing, and filled teeth and surfaces, 3.84 (2.79) and 5.15 (5.74) respectively; mean (SD) number of carious teeth, 3.69 (2.67); proportion carious lesions in anterior teeth, 60%.

† Lesion site, tooth position, size of lesion, and visible plaque.

‡ Odds ratio (OR), 1.98; 95% confidence interval (CI), 1.51 to 2.60.

§ Comparing semiannual with annual applications: OR, 0.64; 95% CI, 0 to 1.26.

¶ The researchers categorized children as having a high visual plaque index score if they were among the 16% of children with the highest score from the whole sample.

# OR, 0.59; 95% CI, 0.49 to 0.72.

\*\* Mean visual plaque index score, 0.69.



## Effectiveness of silver diamine fluoride in caries prevention and arrest: a systematic literature review

Violeta Contreras, DDS ■ Milagros J. Toro, DDS, MSD, PhD ■ Augusto R. Elías-Boneta, DMD, MSD, DHC  
Angeliz Encarnación-Burgos, MPL

**Table 2.** Concentrations and sources of silver diamine fluoride in the studies included in the systematic review.

Concentration	Product	Manufacturer	Country	Studies
38%	Fluoroplat	NAF Laboratorios	Argentina	Llodra et al <sup>38</sup>
10%	Cariostatic	Inodon Laboratório	Brazil	Braga et al <sup>39</sup>
12%	SDF	PROBEM Laboratório de Produtos Farmacêuticos Odontológicos	Brazil	Yee et al <sup>40</sup>
30%	Cariestop	Biodinâmica	Brazil	Dos Santos et al <sup>41</sup> ; Duangthip et al <sup>44</sup>
38%	Saforide	Bee Brand Medical/Toyo Seiyaku Kasei	Japan	Yee et al <sup>40</sup> ; Monse et al <sup>42</sup> ; Zhi et al <sup>43</sup>

## Silver Diamine Fluoride Consent Form

**Silver Diamine Fluoride (SDF)** is a new way to deal with your or your child's tooth decay (i.e., cavities). In some cases, instead of getting fillings it may be possible to use SDF as a non-traumatic and less invasive treatment to stop the tooth decay from progressing.

### Facts about Silver Diamine Fluoride (SDF):

- SDF is an antibacterial liquid, which when painted on a cavity/tooth decay, can stop tooth decay from growing. It can harden up the tooth decay/cavity and can also help treat tooth sensitivity.
- If the cavity keeps growing after it has been treated with SDF, your dental team may suggest that the cavity be treated with traditional treatment (i.e. fillings or possible extraction).
- Treatment with SDF does not always mean that fillings or crowns are not needed. Some cavities need to be fixed to regain tooth function or to repair the way the tooth looks.
- 2 or more applications of SDF are often needed (every 4-6 months) for the SDF to work.

### Do not have SDF treatment if you or your child have:

- 1) An allergy to silver
- 2) Painful sores or raw areas on your/their gums or anywhere in their mouth

### The SDF Procedure:

- 1) The tooth decay/cavities to be treated is dried
- 2) A small amount of SDF is placed on the tooth decay/cavities for 1 minute
- 3) The treated tooth decay/cavities is rinsed with water
- 4) Fluoride varnish is applied to the treated area(s) and all other teeth



### Risks and Discomforts:

- **The cavity treated with SDF will stain dark brown or black forever.** THIS IS GOOD – the black colour shows that the SDF treatment is working and that the tooth decay has stopped growing.
- **Healthy tooth structure will not stain.** However, SDF may stain early signs of tooth decay, which appear as white spots on the teeth. Your dental team may take steps to prevent these areas from staining if they are on permanent front teeth.
- SDF may stain tooth coloured fillings and crowns. Colour changes on the surface can be polished off.
- SDF can temporarily stain skin, the tongue, or gums if it accidentally comes in contact with these tissues. The change in colour will generally disappear within 7-14 days.
- You or your child may notice a metallic taste. This will go away quickly.
- These side effects may not include all of the possible situations provided by the manufacturer.
- If you notice other side effects, please contact your dental clinic. Your dental team will take every needed step to make sure the SDF treatment is successful. **However, there is a risk that the procedure will not stop the tooth decay and there is no guarantee of success.**
- Stopping the active tooth decay process with SDF does not always reduce the need for fillings in teeth. Your or your child's dentist may decide to cover the cavity with a material that has a more natural tooth appearance if desired, but it is not required. If placing a filling on a tooth at a later date, it might not be necessary to use local anesthetic (i.e. dental freezing).

### Alternatives to SDF, not Limited to the Following:

- If you choose not to have the SDF treatment, your/your child's tooth decay/cavities will keep growing. This could lead to the continued breakdown of the teeth and may affect how teeth look. You or your child's teeth might also begin to feel sensitive or painful.
- Depending on where the tooth decay/cavities are and how bad the tooth decay is, the dental team may use other treatment like fluoride varnish, fillings or crowns, root canal treatment (nerve treatment), extraction (taking out teeth), or referral for other treatment.



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## Silver Diamine Fluoride Consent Form

**I, (Participant or Parent/Legal Guardian) confirm that I have read this form and understand it and that all of my questions have been answered. I give permission to provide treatment with Silver Diamine Fluoride for the patient listed below.**

\_\_\_\_\_  
Patient's Name (First and Last Name) PLEASE PRINT CLEARLY

\_\_\_\_\_  
Signature of Patient or Parent/Legal Guardian Date

\_\_\_\_\_  
Signature of Clinic Staff member Date



March 2018



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# Role of SDF in Chronic Disease Management of Caries

DISEASE MANAGEMENT

CDA JOURNAL, VOL 46, N°1



## Chronic Disease Management of Caries in Children and the Role of Silver Diamine Fluoride

Man Wai Ng, DDS, MPH, and Rosalyn Sulyanto, DMD, MS

**ABSTRACT** Chronic disease management (CDM) is a science-based approach that has been demonstrated in early studies to be effective in preventing and controlling dental caries in children. In this article, we describe how CDM can be introduced into contemporary clinical dental practice in which active and engaged dental providers can work as a team to support family behavior changes. We also discuss the role of silver diamine fluoride in the CDM of caries.

**AUTHORS**

**Man Wai Ng, DDS, MPH,** is dentist-in-chief and *DentoQuest* chair in pediatric oral health and dentistry at Boston Children's Hospital. She is also an associate professor at the Harvard School of Dental Medicine. *Conflict of Interest:* Disclosure: Man Wai Ng, DDS, MPH, has received grant funding from the *DentoQuest* Institute and has served as faculty chair in the ECC Collaborative Phases 1-3. She is also the *DentoQuest* endowed chair in pediatric oral health and dentistry at Boston Children's Hospital.

**Rosalyn Sulyanto, DMD, MS,** is assistant in pediatric dentistry at Boston Children's Hospital and an instructor in the department of developmental biology at the Harvard School of Dental Medicine. *Conflict of Interest:* Disclosure: None reported.

Contemporary management of dental caries calls for assessing and understanding an individual's risk of developing caries, applying effective strategies to manage the disease and supplementing with restorative treatment when indicated.<sup>1,2</sup> Historically, the dental profession has primarily relied on restorative and surgical treatment to address dental caries. Young children with early childhood caries (ECC) who are not cooperative often require sedation or general anesthesia. Despite receiving costly surgical treatment, many children develop new and recurrent caries. It is now known that while restorative treatment repairs damaged tooth structure, it alone does not address the underlying disease process.<sup>3</sup> If the responsible risk factors are not adequately addressed, new and recurrent decay will likely develop.<sup>3</sup>

In 2014, the U.S. Food and Drug Administration granted approval for silver diamine fluoride (SDF) to be used as a desensitizing agent, paving the way

for its introduction to the U.S. dental market. The main advantages of SDF include its ability to kill the cariogenic bacteria, provide caries arrest without requiring the use of local anesthesia or caries excavation and promote remineralization.<sup>4,5</sup> These advantages are particularly appealing in the care of young children and children with special health care needs who are not able to receive traditional restorative treatment. The main concerns of SDF use pertain to possible over-exposure to fluoride and objection by parents (and patients) to the black staining of the carious lesions.<sup>6</sup> Crystal et al. found that parents of young children report greater dissatisfaction to having discolored anterior teeth compared to posterior teeth; however, many parents are apparently more willing to accept the discoloration if sedation or general anesthesia procedures could be avoided.<sup>7</sup>

Studies have reported on the effectiveness of SDF to arrest caries and its efficacy to prevent new caries in primary teeth as well as first permanent

TABLE 1

## ECC Chronic Disease Management Protocol\*

Caries risk assessment	<ul style="list-style-type: none"><li>■ Performed in full or abbreviated format during each visit</li><li>■ Children who have at least one tooth with demineralization or cavitation lesion is an ECC patient</li></ul>
Effective communication	<ul style="list-style-type: none"><li>■ With permission, explain the caries process to parent and use structured communication strategies such as:<ul style="list-style-type: none"><li>• Fixing the cavities does not fix the problem</li><li>• Without a change in diet and home care, new cavities and broken fillings will result</li><li>• Change is hard and won't happen over night</li></ul></li></ul>
Self-management goal setting	<ul style="list-style-type: none"><li>■ Engage and coach parent to select one or two goals to work on until the next visit</li><li>■ Goals may include more frequent toothbrushing, topical fluoride use and specific diet modification strategies</li></ul>
Caries charting	<ul style="list-style-type: none"><li>■ Use a charting system, such as ICDAS or ADA Caries Classification System to:<ul style="list-style-type: none"><li>• Document caries by tooth, surface and activity</li><li>• Monitor disease improvement or progression</li></ul></li></ul>
Fluorides and other remineralization strategies	<ul style="list-style-type: none"><li>■ Topical fluorides, including over-the-counter toothpaste, stannous fluoride, xylitol and/or calcium phosphate products can be offered</li><li>■ In-office silver diamine fluoride treatment or fluoride varnish applications can be offered</li></ul>
Restorative treatment	<ul style="list-style-type: none"><li>■ Full range of treatment options can be presented based on each patient's needs and parent's desires, including:<ul style="list-style-type: none"><li>• Conventional treatment (including use of pharmacologic management)</li><li>• Interim therapeutic restorations for caries control and sealants</li></ul></li></ul>
Risk-based recare intervals	<p>Patients are recommended to return in:</p> <ul style="list-style-type: none"><li>■ 1-3 months (if high risk)</li><li>■ 3-6 months (if medium risk)</li><li>■ 6-12 months (if low risk)</li></ul> <p>At the recare/disease management visit, perform:</p> <ul style="list-style-type: none"><li>■ Caries risk assessment</li><li>■ Self-management goal setting</li><li>■ Exam and charting</li><li>■ X-rays if indicated</li><li>■ Silver diamine fluoride or fluoride varnish</li></ul>

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# WRHA Section of Pediatric Dentistry Guidelines on the use of General Anesthesia for Pediatric Dental Patients

Developed by the WRHA Section of Pediatric Dentistry Working Group

## The decision to use general anesthesia must take into consideration all of the following:

- alternative modalities (e.g., nitrous oxide/oxygen inhalation if an option in your office, protective stabilization, sedation if an option in your office);
- age of the patient;
- risk benefit analysis;
- treatment deferral (e.g., Interim Therapeutic Restorations (ITR)/Alternative Restorative Techniques (ART), silver diamine fluoride, allow for eruption of all primary teeth, delay treatment until child can tolerate treatment in the chair, until teeth can exfoliate);
- dental needs of the patient;
- the effect on the quality of dental care;
- the patient's emotional development; and
- the patient's medical status.





# WRHA Section of Pediatric Dentistry Guidelines on the use of General Anesthesia for Pediatric Dental Patients

Developed by the WRHA Section of Pediatric Dentistry Working Group

## Indications: General anesthesia is indicated for:

- patients who cannot cooperate due to a lack of psychological or emotional maturity and/or mental, physical, or medical disability;
- patients for whom local anesthesia is ineffective because of acute infection, anatomic variations, or allergy;
- the extremely uncooperative, fearful, anxious, or uncommunicative child or adolescent;
- patients requiring significant surgical procedures (e.g., multiple teeth requiring restorative treatment (fillings and stainless steel crowns) or extraction);
- patients for whom the use of general anesthesia may protect the developing psyche and/or reduce medical risk; and
- patients requiring immediate, comprehensive oral/dental care.

## Contraindications: The use of general anesthesia is contraindicated for:

- a healthy, cooperative patient with minimal dental needs;
- a patient with minimal dental needs, including very young children, that can be addressed with therapeutic interventions and secondary prevention (e.g., ITR, fluoride varnish, silver diamine fluoride) and/or treatment deferral;
- parent/patient/practitioner convenience; and
- predisposing medical conditions which would make general anesthesia inadvisable.

