



## An Overview of Pedagogical Approaches to Caries-Control Medications in Canadian Dental and Dental Hygiene Programs

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### ABSTRACT

**Objective:** To investigate pedagogical approaches and perceived barriers to teaching about caries-control medications, particularly silver diamine fluoride (SDF), in Canadian undergraduate dental and dental hygiene programs.

**Methods:** In summer 2018, a 9-item questionnaire was distributed to all 10 dental schools and 32 dental hygiene programs in Canada. It enquired about the types of caries-control medications used, teaching methods and perceived barriers to instruction on managing active caries with SDF.

**Results:** The response rate was 80% ( $n = 8$ ) from dental schools and 72% ( $n = 23$ ) from dental hygiene programs. All curricula included information about conventional caries-control medications: fluoride, silver nitrate and povidone iodine. In all programs, instruction regarding SDF was predominantly didactic: 93% of programs presented lectures on SDF and 30% of programs included clinical teaching and use of SDF in primary dentition only. The lack of consensus on clinical protocols outlining the number and frequency of SDF applications to arrest caries was cited by 43% of the programs as a barrier to clinical teaching.

**Conclusions:** There is some variation across Canada in pedagogical approaches to caries-control medications and the inclusion of SDF in curricula. Poorly defined clinical protocols were reported as the main barrier to didactic and clinical use of SDF in undergraduate dental education programs.

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Oral health has long been recognized as a basic human right.<sup>1</sup> However, in Canada, oral health is excluded from the federally funded health care system and access is challenging for those who are economically disadvantaged.<sup>2-5</sup> Complex surgical and restorative dental treatment of teeth affected by caries may be too costly for many. Instead, active carious lesions may be managed by promoting remineralization of affected enamel and dentin via non-surgical methods, including topical application of fluoride, silver nitrate and povidone iodine. In February 2017, silver diamine fluoride (SDF) was approved for use by Health Canada.<sup>4</sup> SDF is a colourless solution of silver (25%), ammonia (8%), fluoride (5.5%) and water (62%) that has been demonstrated to arrest dental caries effectively. To date, most literature discusses its use in the primary dentition,<sup>4,6-12</sup> with very few studies including adults and older adults with root caries.<sup>13,14</sup>

The current extent to which SDF has been integrated into routine clinical care in Canada is unknown. Recent reports have focused on its incorporation into the caries management curricula of United States dental schools.<sup>15,16</sup> These studies suggest considerable variation, both in terms of the extent to which SDF is taught in undergraduate<sup>15</sup> and graduate dental programs<sup>16</sup> and of acceptable clinical protocols for its use.<sup>17,18</sup> The amount of clinical and didactic instruction focused on SDF and other caries-control medications in Canadian dental programs is largely unknown.<sup>19</sup> Educational institutions have traditionally been resistant to change when shifting from restorative and prosthetic procedures to more conservative, non-surgical and minimally invasive caries management methods.<sup>20,21</sup>

The objectives of this study were to investigate the teaching practices and perceived barriers to instruction on caries-control medications, particularly SDF, in Canadian dental and dental hygiene educational programs.

## Methods

A non-systematic, yet comprehensive, literature search was initiated using the keywords “caries control” AND “silver diamine fluoride”, AND “education” on PubMed/Medline. The search was limited to full-text studies on humans published in English, Portuguese or Spanish (languages that the authors could understand) between 1970 and August 2018. A supplementary search for conference proceedings and graduate theses was undertaken using ProQuest and the same keywords. MS identified publications, screened them and excluded those failing to meet the search criteria based on the study objectives. Two pairs of independent researchers (MAB and CMCA; MS and IA) scrutinized the title, abstract and text of the selected publications and included those of relevance to the study. The researchers then met to discuss discrepancies until consensus

was reached on which studies to include. Although the literature was searched comprehensively, this manuscript does not present a regular systematic review and meta-analysis for quality assessment given that there was no patient, intervention, comparison and outcome (PICO) question.

In all, 26 full-text articles were included based on their relevance to the study objectives, i.e., describing teaching pedagogies or methods pertaining to caries-control medications and instructions on SDF use. Of these, 12 reported on both didactic and clinical pedagogical approaches to the use of caries-control medications, including SDF. Some studies reviewed SDF instruction at the undergraduate level,<sup>22</sup> while others focused on the graduate level.<sup>16</sup> Two studies presented the clinical protocols used to apply SDF.<sup>17,22</sup> Most studies mentioning SDF (22) were from the United States, 2 were from Canada,<sup>19,20</sup> 1 was from Australia and New Zealand<sup>23</sup> and 1 was from Brazil.<sup>24</sup> Based on these 26 studies, the use of caries-control medications is taught primarily via didactic methods, as a stand-alone subject or within a more robust course, usually restorative or operative dentistry or cariology. These methods include varying combinations of lectures, case presentations, problem-based learning, case studies, videos and undergraduate/graduate curricula. A few studies present a combination of didactic teaching on the application of SDF in a simulation environment (e.g., extracted teeth) or in a clinical care context involving patients, albeit mostly children.

Based on what we learned from the literature review pertaining to pedagogical approaches to teaching about caries-control medications, we developed a 9-item questionnaire in English only (**see: Appendix**), adapted from a 2016 study by Nelson et al.<sup>16</sup> The questionnaire included identifying which medications were covered in the curricula and whether didactic instruction took place in lecture, seminar or simulation formats or together with clinical application of these substances. We also asked participants to describe any perceived barriers to teaching minimally invasive management of active lesion strategies using these caries-control medications, seeking information on SDF use in particular.

The questionnaire was pilot tested by 5 faculty members and graduate students to ensure clarity and comprehensiveness before it was sent to all 10 dental schools and 32 dental hygiene programs in Canada via an email attachment in the summer of 2018. We identified potential respondents by examining the websites of these programs; in addition, the questionnaire was sent to deans/directors and department heads with a request to forward it to an appropriate faculty member when no names were identified from their websites. After 2 weeks, a reminder email was sent to those programs and schools that had not responded. A third and final request was sent 4 weeks after the initial email.

Respondents could either complete the questionnaire as an MS Word document (Microsoft Corp., Redmond, Washington, USA)

and email it back or print it out and fax it back. Only 1 response was collected for each institution; those with both undergraduate dental and dental hygiene programs counted as a single response. Descriptive analyses were completed to show the percentages and distribution of the responses.

## Results

The response rate from Canadian dental schools was 80% (8 out of 10) and from Canadian dental hygiene programs 72% (23 out of 32). All schools and programs reported including the topic caries-control medications. The agents most commonly reported were fluoride varnish (92.3%), acidulated phosphate fluoride foam (88.5%), silver nitrate (26.9%) and povidone iodine (23.1%) with an even distribution between the schools and programs (Table 1). In terms of SDF, 1 dental school and 3 dental hygiene programs reported not addressing its use at all, either didactically or clinically in a formal course or module at the time the questionnaires were returned. Among dental schools and dental hygiene programs that taught the use of SDF, didactic formats varied widely and included lectures, case discussions,

videos and problem-based learning (Table 1). Five of the dental schools reported teaching clinical use of SDF for children, while 2 also taught its clinical use in adults. Of the dental hygiene programs, 14 taught the clinical use of SDF for children, while only 1 did so for adult patients.

The most commonly reported barriers to teaching about the use of SDF included lack of consensus on clinical guidelines in terms of the number and frequency of SDF applications needed to arrest caries (4 dental schools; 9 dental hygiene programs) and lack of training and experience using SDF (4 dental schools; 5 dental hygiene programs). Other barriers included lack of curriculum time, unclear patient benefits, heavy staining of caries by SDF, unclear reimbursement processes and lack of interest. Three respondents described lack of institution support — or a champion — for incorporating teaching of SDF across their curricula. About half of respondents from both the dental schools ( $n = 5$ ) and the dental hygiene programs ( $n = 15$ ) agreed or strongly agreed with the use of SDF as a mainstream therapy for all patients with active caries lesions, not just for high-risk individuals or children.

**Table 1:** Teaching and use of caries-control medications in Canadian dental schools (8 respondents) and dental hygiene programs (23 respondents).

	Teach, no. (%)		Use, no. (%)	
	Didactic	Clinical	Simulation	Clinical*
Silver diamine fluoride	23 (74.2)	16 (51.6)	11 (35.5)	11 (35.5)
Povidone iodine	6 (19.4)	0 (0)	0 (0)	0 (0)
Silver nitrate	7 (22.5)	1 (3.2)	1 (3.0)	0 (0)
Fluoride varnish†	24 (77.4)	24 (77.4)	10 (32.2)	24 (74.4)
Acidulate phosphate fluoride foam‡	23 (74.2)	7 (22.5)	2 (6.5)	5 (16.1)
Acidulate phosphate fluoride gel‡	25 (80.6)	4 (13.0)	9 (29.0)	16 (51.6)

Please note that the numbers may overlap because the same school/program may teach and/or use more than one product via different means (e.g., use in simulation and in clinic).

\*In clinical teaching, 6% of the respondents used silver diamine fluoride for adults and older adults.

†Concentration of 5%

‡Concentration of 1.23% or 2%

## Discussion

This study reviewed the available literature on pedagogical approaches to caries-control medications, particularly SDF and then surveyed Canadian dental and dental hygiene programs on their teaching practices regarding caries control and perceived barriers to incorporating SDF into their curricula. The questionnaire had a return rate similar to other studies on the same topic, above 70%,<sup>15,16</sup> which is much higher than the estimated 10% response rate for mailed out surveys.<sup>26</sup>

Other studies have also shown that the topic of caries-control medications has primarily been taught using didactic methods, ranging from lectures to videos and case studies, as we found herein; fewer studies have reported the clinical use of SDF when describing pedagogies, despite overwhelming evidence of safe, efficacious use of SDF as a minimally invasive topical agent to arrest active carious lesions.<sup>13,14</sup> As highlighted by Fontana and colleagues,<sup>21</sup> there is critical momentum to include non-surgical caries management in didactic and clinical approaches so that the traditional restorative and prosthetic methods can be contested,<sup>20</sup> and risk-based caries management and personalized prevention may be more readily adopted.<sup>25</sup>

With the exception of fluoride varnish, our results showed that other medications were used at a higher rate than reported in the study that used the questionnaire on which ours was based<sup>16</sup>; however, that study involved a graduate program in pediatric dentistry. It found that 48.6% of programs used acidulated fluoride foam, 9.5% used silver nitrate and 1.3% used povidone iodine. These discrepancies might be because Nelson's study<sup>16</sup> focused on graduate programs only, and more specifically on clinical use of SDF, which was equally low in our study, in terms of didactic teaching (Table 1).

Both dental and dental hygiene programs reported that clinical use of SDF was predominantly focused on children (70%), which correlates with currently available literature. A lack of consensus on the frequency of application was listed as the main barrier to inclusion of SDF in teaching clinics. Other studies have also noted the lack of a widely accepted, evidence-based protocol for SDF as another barrier preventing its use clinically. This lack of evidence remains a major hurdle to the full adoption of this non-surgical dental caries treatment.<sup>21,23</sup> Surprisingly, the black-staining side effect<sup>27</sup> was not reported as a major barrier to clinical use, contrary to other studies.<sup>28,29</sup> This might be because dark staining is frequently reported as influencing the acceptability of this treatment by patients,<sup>26</sup> but does not necessarily influence how oral health care providers view its application.<sup>28,30</sup>

In addition, some respondents mentioned the lack of a champion to advocate the teaching of SDF as a barrier, particularly when

there is a lack of institutional support. Champions have indeed been instrumental in the implementation of evidence-based dentistry<sup>31</sup> and in prompting daily oral health care practice in long-term care homes.<sup>32,33</sup> Similar to United States dental schools mentioned in a study by Ngoc and colleagues,<sup>15</sup> most Canadian institutions varied in teaching involving SDF, while consistently focusing on its use to arrest coronal dental decay in primary teeth only. Weintraub et al.<sup>18</sup> recently concluded that the existence of an easy-to-use protocol is a strong determinant of SDF uptake in clinical settings. In health care systems where basic dentistry remains unaffordable for many, as in Canada, the use of SDF as a mainstream procedure may fall within a dental public health mandate, leading to the need for robust undergraduate pedagogies aimed at sensitizing future dentists to a career focused on dental public health.<sup>34</sup>

The idea of promoting the widespread use of SDF is supported by the fact that most respondents (66%) from both dental schools and dental hygiene programs agreed or strongly agreed with its use as a mainstream therapy for all patients, regardless of age or socioeconomic status. As more studies emerge, SDF might indeed show evidence of arresting and preventing root and coronal caries in adults and older adults, as long as patients are well informed about the risks and benefits.<sup>35</sup>

The strengths of this study are related to its relatively high response rate. The limitations of the review method used to develop the questionnaire include the languages used to select the literature, which might have excluded studies in languages other than English, Spanish and Portuguese. The limitations of the questionnaire include its design and lengthy questions, response bias and potential recall bias among respondents. It also includes the potential for socially desirable responses, as respondents from the schools and programs might have felt pressured to participate in instances where they knew the researchers. Another limitation was the fact that the questionnaire was available only in English, and only 2 French-language institutions replied. In addition, some dental and dental hygiene programs are based at the same university and might have returned more than 1 questionnaire but were only counted as a single submission. As widely accepted and standardized evidence-based guidelines for the use of SDF and its evaluation must be further agreed on, follow-up studies should explore the extent to which dental professionals use SDF in their practices. Further studies should discuss the need to better align operative dentistry education with preventive dentistry education and should consider the inclusion of ways to teach proper SDF use for internationally trained dentists holding a licence to practise in Canada.

## Conclusions

Dental education worldwide appears to have included the topic of caries-control medications, either as a stand-alone component of the curricula or as a topic within other disciplines, with some including the teaching of SDF use. Most Canadian dental and dental hygiene schools include caries-control medications

in their curricula; however, the use of SDF is taught both didactically and clinically in fewer schools. Unclear guidelines are the main barrier preventing comprehensive teaching and use of SDF clinically. Widely accepted and standardized evidence-based guidelines for the use of SDF must be agreed on.

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## Appendix:

Questionnaire to explore teaching and use of caries-control medications in Canadian dental schools and dental hygiene programs.\*



THE UNIVERSITY OF BRITISH COLUMBIA

Faculty of Dentistry

### 1) For information purposes only, which of the following would apply to your school/faculty/program?

- Dental school – university       Dental hygiene – 2-year diploma  
 Dental hygiene – 3-year diploma       Dental hygiene – bachelor's degree

### 2) Does your school/faculty/program currently teach and/or use any of the following caries control agents (medicaments) at the undergraduate level (chose all that apply):

	TEACH		USE	
	Didactic	Clinical	Simulation	Clinical
<i>Silver diamine fluoride</i>	( ) YES ( ) NO			
<i>Povidone iodine</i>	( ) YES ( ) NO			
<i>Silver nitrate</i>	( ) YES ( ) NO			
<i>Fluoride varnish (5% NaF; 22,000 ppm)</i>	( ) YES ( ) NO			
<i>Acidulate phosphate fluoride foam (1.23% APF; 12,300 ppm) (2% NaF; 9,050 ppm)</i>	( ) YES ( ) NO ( ) YES ( ) NO	( ) YES ( ) NO ( ) YES ( ) NO	( ) YES ( ) NO ( ) YES ( ) NO	( ) YES ( ) NO ( ) YES ( ) NO
<i>Acidulate phosphate fluoride gel (1.23% APF; 12,300 ppm) (2% NaF; 9,050 ppm)</i>	( ) YES ( ) NO ( ) YES ( ) NO	( ) YES ( ) NO ( ) YES ( ) NO	( ) YES ( ) NO ( ) YES ( ) NO	( ) YES ( ) NO ( ) YES ( ) NO
Other (please specify): _____				

### 3) If you do not teach/use any of the above products at the undergraduate level, please go to question 5.

### 4) If you teach and/or use any of the above products at the undergraduate level, which means do you use to teach about these products (choose all that apply):

<i>Silver diamine fluoride</i>	• Lecture format	( ) YES	( ) NO
	• Case discussion (large group format)	( ) YES	( ) NO
	• Case discussion (small group format)	( ) YES	( ) NO
	• Simulation (mannequin, extracted teeth)	( ) YES	( ) NO
	• Clinical use		
	- Children (primary teeth)	( ) YES	( ) NO
	- Children, (permanent teeth)	( ) YES	( ) NO
	- Adults (permanent teeth)	( ) YES	( ) NO
	- Older adults (root caries)	( ) YES	( ) NO
	Other (please specify): _____		
<i>Povidone iodine</i>	• Lecture format	( ) YES	( ) NO
	• Case discussion (large group format)	( ) YES	( ) NO
	• Case discussion (small group format)	( ) YES	( ) NO
	• Simulation (mannequin, extracted teeth)	( ) YES	( ) NO
	• Clinical	( ) YES	( ) NO

## Appendix:

Questionnaire to explore teaching and use of caries-control medications in Canadian dental schools and dental hygiene programs.\*



THE UNIVERSITY OF BRITISH COLUMBIA

Faculty of Dentistry

- Children (primary teeth)  YES  NO
- Children, permanent teeth  YES  NO
- Adults (permanent teeth)  YES  NO
- Older adults (root caries)
- Other (please specify): \_\_\_\_\_

### Silver nitrate

- Lecture format  YES  NO
- Case discussion (large group format)  YES  NO
- Case discussion (small group format)  YES  NO
- Simulation (mannequin, extracted teeth)  YES  NO
- Clinical
  - Children (primary teeth)  YES  NO
  - Children, permanent teeth  YES  NO
  - Adults (permanent teeth)  YES  NO
  - Older adults (root caries)  YES  NO
- Other (please specify): \_\_\_\_\_

### Fluoride varnish

- Lecture format  YES  NO
- Case discussion (large group format)  YES  NO
- Case discussion (small group format)  YES  NO
- Simulation (mannequin, extracted teeth)  YES  NO
- Clinical
  - Children (primary teeth)  YES  NO
  - Children, permanent teeth  YES  NO
  - Adults (permanent teeth)  YES  NO
  - Older adults (root caries)  YES  NO
- Other (please specify): \_\_\_\_\_

### Acidulate phosphate fluoride (foam)

-1.23% APF; 12,300 ppm   
-2% NaF; 9,050 ppm

- Lecture format  YES  NO
- Case discussion (large group format)  YES  NO
- Case discussion (small group format)  YES  NO
- Simulation (mannequin, extracted teeth)  YES  NO
- Clinical
  - Children (primary teeth)  YES  NO
  - Children, permanent teeth  YES  NO
  - Adults (permanent teeth)  YES  NO
  - Older adults (root caries)  YES  NO
- Other (please specify): \_\_\_\_\_

### Acidulate phosphate fluoride (gel)

-1.23% APF; 12,300 ppm   
-2% NaF; 9,050 ppm

- Lecture format  YES  NO
- Case discussion (large group format)  YES  NO
- Case discussion (small group format)  YES  NO
- Simulation (mannequin, extracted teeth)  YES  NO
- Clinical
  - YES  NO
  - YES  NO

## Appendix:

Questionnaire to explore teaching and use of caries-control medications in Canadian dental schools and dental hygiene programs.\*



THE UNIVERSITY OF BRITISH COLUMBIA

Faculty of Dentistry

- Children (primary teeth) ( ) YES ( ) NO
- Children, permanent teeth ( ) YES ( ) NO
- Adults (permanent teeth)
- Older adults (root caries)
- Other (please specify): \_\_\_\_\_

Other (please specify): \_\_\_\_\_

**5) What do you teach as the preferred frequency of application of silver diamine fluoride to carious teeth in your school/faculty/program:**

Please specify: \_\_\_\_\_

**6) In terms of undergraduate teaching and use of SDF, to what extent to do agree or disagree with the following statements:**

	Strongly agree	Agree	Disagree	Strongly disagree
It should be used on high-risk patients only	( )	( )	( )	( )
It should be used as a mainstream therapeutic intervention to arrest carious lesions.	( )	( )	( )	( )
It should be used with a separate consent including before and after photos	( )	( )	( )	( )
It should be used on incipient lesions of:				
• Primary teeth	( )	( )	( )	( )
• Permanent teeth	( )	( )	( )	( )
• Older adults' teeth	( )	( )	( )	( )
It should be used on cavitated lesions of:				
• Primary teeth	( )	( )	( )	( )
• Permanent teeth	( )	( )	( )	( )
• Older adults' teeth	( )	( )	( )	( )
It should be used on decayed crowned teeth:				
• Primary teeth	( )	( )	( )	( )
• Permanent teeth	( )	( )	( )	( )
• Older adults' teeth	( )	( )	( )	( )
Patients should receive SDF treatment if they:				
• Present with behavioural issues that precludes restoration	( )	( )	( )	( )
• Cannot afford restorations	( )	( )	( )	( )
• Are medically fragile	( )	( )	( )	( )
• Are frail	( )	( )	( )	( )
• Other (please specify): _____				
Patients cannot receive SDF treatment if they:				

## Appendix:

Questionnaire to explore teaching and use of caries-control medications in Canadian dental schools and dental hygiene programs.\*



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• Present with behavioural issues	( )	( )	( )	( )
• Cannot consent	( )	( )	( )	( )
• Do not understand the mechanism of action	( )	( )	( )	( )
• Other (please specify): _____				

**7) If you perceive or experience any barriers to implementation of SDF in regular clinical care at the undergraduate level, what would these barriers be:**

Please specify: \_\_\_\_\_

**8) If you perceive or experience any barriers to teaching the use of SDF at your program/school/university at the undergraduate level, what would these barriers be:**

Please specify: \_\_\_\_\_

**9) Please, feel free to comment or give us feedback on the questionnaire and/or the topic of SDF in the space below:**

\_\_\_\_\_