

## Concise Review

## Silver Diamine Fluoride: Transforming Community Dental Caries Program

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## ABSTRACT

**Introduction:** Untreated dental caries is the most frequent childhood chronic disease worldwide. Silver diamine fluoride (SDF) offers a safe and effective alternative treatment, especially for children.

**Objective:** To inform the dental community about the efficacy of SDF in community dental caries programs and to advocate for its use as an affordable and equitable approach to promote health and well-being within the dental setting.

**Methods:** A summary of the literature shared during a webinar about the use and efficacy of SDF in community dental programs hosted by the Oral Health Working Group of the World Federation of Public Health Associations

**Results:** Based on the traditional “drill-and-fill” approach, the current treatment for severe caries is associated with pain, fear, and poor oral health outcomes in later life. Innovative approaches to prevent and control caries are needed. SDF offers an alternative treatment option for caries. It is a practical, affordable, and acceptable option for caries treatment, eliminating the need for general anaesthetic in young children, and improving long-term oral health outcomes.

**Conclusion:** SDF can improve oral health outcomes for community members, especially for individuals from low-socioeconomic settings.

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## Introduction

Untreated dental caries in permanent teeth is the most common health condition amongst adults<sup>1</sup> in both low- and middle-income countries and more economically developed countries.<sup>2</sup> Children are also severely affected, with 530 million children suffering from dental caries of primary teeth each year.<sup>3</sup> Dental care is one of the greatest unmet health care needs in children and many childhood caries left untreated, especially in low- and middle-income countries because the treatment costs exceed available resources.<sup>4</sup> Oral diseases represent a major challenge for public health because a lack of access to treatment can negatively affect quality of life, body weight, growth, and school attendance

and performance,<sup>4</sup> making effective treatment of paramount importance.

Current treatment of oral diseases, including dental caries, is expensive, presenting a considerable financial burden to both families and health care providers.<sup>5</sup> The cost also means that children living in poverty, socially marginalised groups, and older people are the most affected by oral diseases because of poor access to dental care. Moreover, even if individuals can access treatment, current treatment for severe caries in children involves administration of general anaesthesia to reduce pain and anxiety. Undergoing such procedures has been associated with poor oral health and dental anxiety in later life, in addition to predisposing children to develop dental caries in the permanent dentition.<sup>6</sup> As a result, innovative, affordable and equitable approaches to prevent and control caries and promote health and well-being are needed.<sup>7</sup>

Treatment of caries in primary teeth with nonrestorative intervention offers a promising alternative approach.<sup>8</sup> Silver

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diamine fluoride (SDF) is a colourless, odourless alkaline solution that has been used successfully to arrest carious lesions in those unable to tolerate invasive treatment, children, elderly populations, and those who are medically compromised or have additional care and support needs.<sup>9</sup> Although the mechanism of action of SDF is contested,<sup>10</sup> SDF treatment has been found to promote tooth desensitisation and carious lesion arrest by dentinal tubule blockage, cariogenic bacterial death, remineralisation of the demineralised tooth, and inhibition of dentinal collagen degradation.<sup>9</sup> SDF is an effective, efficient, safe, and affordable agent for preventing caries.<sup>11</sup>

To synthesise the current literature, inform the dental community, and promote the use of SDF in community dental caries programs, the Oral Health Working Group (OHWG) of the World Federation of Public Health Associations (WFPHA) hosted a webinar on October 10, 2019. The key messages of the webinar and the calls to action that were made are summarised in this article. The webinar brought together global experts to discuss the public health implications of using SDF in community dental programmes. The webinar, which was part of the #DPHTalks series led by WFPHA OHWG, was titled “Silver Diamine Fluoride – Transforming Community Dental Caries Programmes.” It discussed how carious lesions have traditionally been managed by conventional “drill-and-fill” treatments;<sup>9</sup> how caries are now considered as a behaviourally mediated, biofilm-based disease,<sup>9</sup> involving dietary sugars, bacterial metabolism, demineralisation, and organic degradation; and the new approach of “seal and heal.”<sup>12</sup>

For decades, restorative dentistry, using the drill-and-fill approach, was the only available treatment of dental caries that showed substantial efficacy in the United States.<sup>13</sup> However, the treatment is expensive and, thus, access is limited to those from low-socioeconomic groups. Supporting this, recent evidence highlights that in the United States, for both total and untreated caries, prevalence decreased as family income level increased, with the highest prevalence of total caries in Hispanic youth.<sup>14</sup> As a result, despite large increases in oral health spending and the number of dental professionals employed in the United States, the prevalence of dental caries remains high.<sup>15</sup> In 2016, prevalence of total caries was 45.8% and untreated caries was 13% among youth aged 2-19 years. Untreated caries can cause pain and reduced well-being.<sup>16</sup> Therefore, alternative treatments for dental caries are necessary.

In 2015, SDF became available on the US market,<sup>17</sup> offering a new form of noninvasive caries management. Extensive research supports the efficacy of SDF for caries arrest and caries prevention.<sup>8</sup> While some challenges exist with using SDF, for instance staining has been reported,<sup>18</sup> the safety of SDF has been extensively supported because not a single adverse event has been reported since SDF was first used in Japan more than 80 years ago.<sup>19</sup> Recent randomised control trials conducted in Hong Kong indicated that SDF can reduce carious lesions in children, with a greater likelihood of caries becoming arrested if SDF is applied twice per year at a concentration of 38%.<sup>20,21</sup> This approach is recommended because it can arrest caries without causing excessive staining.<sup>20</sup> However, a single application of SDF at a concentration of 38% was found to be effective in arresting dentin caries in primary anterior teeth in preschool children after 6 months.<sup>8</sup> This indicates that SDF could offer a treatment approach for

those with limited resources. Such research supports the use of minimally invasive (MI) treatment in the prevention of dental caries. MI treatments offer an attractive alternative to managing carious lesions.<sup>13</sup> Following this, there has been a recent paradigm shift in cariology toward seal and heal and a MI treatment approach that is not only cheaper but also has fewer negative effects for the patient.

Atraumatic restorative treatment (ART) is a MI approach for carious lesion treatment that involves the removal of demineralised tissue with hand instruments only to keep pain to a minimum.<sup>13</sup> As atraumatic restorative treatment can be conducted in nonclinical settings it also increases access to care in the community setting.<sup>13</sup> Recently, the silver-modified atraumatic restorative treatment (SMART) technique, which involves treatment of the carious lesion with SDF and then restored with a glass ionomer, was developed. This technique can effectively arrest caries without removal of additional tooth structure, offering a promising treatment approach for caries treatment in early childhood caries and root caries in elderly patients. As a result, SMART has a role to play in the secondary and tertiary prevention of caries and should, therefore, be implemented in community dentistry programmes globally.

Community or place-based SDF treatments have also been proposed for the management of dental caries in children, with a focus on reducing the inequalities in caries experienced.<sup>22</sup> One such place-based intervention, CarriedAway, was first implemented in a school setting in 2003. The programme involved taking cavity prevention measures, including toothbrushes, toothpaste, fluoride varnish, and glass ionomer treatments. After 6 years, the programme resulted in significant reductions in untreated caries.<sup>23</sup> CarriedAway 2.0 was implemented later, following the same protocol, but using SDF instead of glass ionomer. The treatment time and costs were also reduced by approximately 33% (10-minute treatment time, compared to 30 minutes and \$25 compared to \$70). CarriedAway 2.0 is currently in the second year of a cluster randomised control trials, with approximately 25,000 children across schools in New York and New Hampshire. Initial results, which is the largest caries-reduction program in US schoolchildren, indicate that caries are decreasing in both populations, despite the reduced treatment cost and time. Moreover, preliminary models also support the efficacy of the SDF programme, suggesting that the programme could eliminate 80% of caries and cost less than 20% of the current Medicaid children’s oral health spending.<sup>24</sup> Although the results of the CarriedAway programmes relate to children, the results are also relevant to other population groups across the age spectrum.

Another example of SDF use in a place-based community dentistry intervention in the reduction or arrest of caries comes from Hong Kong where the Faculty of Dentistry from the University of Hong Kong implemented the “Preschool Oral Health Programme” involving more than 200,000 preschool children.<sup>25</sup> The program offered oral health education for teachers and parents and provided oral examination and SDF treatment for caries control. Evaluations of the intervention found that improved oral health outcomes occurred within 6 months of treatment being commenced.<sup>25</sup> No statistically significant difference in improvement rates between children were found, despite variations in prior oral health

practices and their socioeconomic backgrounds.<sup>25</sup> One of the most impressive outcomes of the treatment was the high acceptance among parents, with greater than a 90% participation rate. This support for the treatment approach spread across Hong Kong and eventually resulted in the population encouraging the university to implement the SDF treatment across the whole island. Such research indicates that SDF treatment can benefit preschool children. Because caries experience is unevenly distributed in Hong Kong, with most occurring in underprivileged children, interventions in the school setting offer an effective and equitable caries treatment solution that does not rely on dental knowledge or access to a dental practice.<sup>26</sup>

SDF has also been used in Australia, with unpublished research from Melbourne Dental Hospital, led by Rans Yawary, indicating that the noninvasive treatment can significantly reduce the number of children needing a general anaesthetic for caries treatment and can reduce pain and sepsis in those with severe carious lesions. SDF has simple treatment protocols and can be applied with a minimum of equipment. As such, SDF enables an important triage service in resource-poor areas, where populations suffer from extensive dental disease. Unpublished research by Dental Health Services Tasmania, supports the use of SDF in providing care in remote locations, improving access to treatment, reducing treatment costs, reducing waiting times, and limiting the need to visit hospital on multiple occasions. These findings led to SDF use in every government clinic in Tasmania. Additional research also supports the use of SDF as a well-accepted, easy-to-use, and effective treatment of dental caries in young Aboriginal children living in remote areas, further supporting the equity and accessibility of the approach.<sup>27</sup> Finally, evidence shows that SDF ensures that carious tooth tissue does not need to be removed to stop disease progression, which ensures that the tooth structure is preserved, making the treatment a more successful strategy in the longer term.<sup>28</sup>

Despite advances in dental care over recent years, dental caries is still a global health problem.<sup>20</sup> Children from lower-socioeconomic groups and those whose parents have minimal education are disproportionately affected by caries because conventional dental care is unaffordable or unavailable.<sup>2</sup> Even if services are available, traditional drill-and-fill approaches for caries in children often require general anaesthesia because of the complexity of treatment and the pain induced.<sup>29</sup> As a result, treatment is higher risk and requires sophisticated dental equipment, which places a considerable financial burden on families and health care providers.<sup>5</sup> As a result, much of the caries experienced goes untreated, resulting in disease and a decreased quality of life for the affected children and their families. A novel, community-based approach is needed to ensure that the caries problem can be solved equitably. SDF, which was first developed in Japan in the 1970s, is one such treatment method that has been gaining global interest in recent years.<sup>22</sup>

## Conclusion

Studies highlight that SDF is an effective treatment method for dental caries,<sup>11,30,31</sup> as well as in older patients. In

support, initial results from the CarriedAway programme in the United States, combined with modelling data of the intervention, support the efficacy of SDF in eliminating caries. The programme also indicates that community interventions using SDF could cost less than 20% of the current Medicaid children's oral health spending,<sup>23</sup> helping to make dental care more affordable. Such results support the implementation of a radically new approach to community-based school programs, especially because they offer a simple, pain-free treatment approach with community support.<sup>27</sup>

Taken together, the WFPHA OHWG webinar presentations highlight that the use of SDF in clinical and community settings offers a safe, effective, practical, equitable, and acceptable option for the treatment of carious lesions, both for early childhood caries and root cavities experienced by elderly patients.<sup>20,31</sup> Incorporating SDF into community dentistry programs could attract patients who do not traditionally see the dentist, which could reduce the prevalence of caries globally and make health care more accessible. For countries that do not yet have access to SDF, silver nitrate (AgNO<sub>3</sub>) plus sodium fluoride (NaF) could be used as an alternative treatment option.<sup>20</sup>

## Key findings

- If applied early, when the cavity is present but has not caused irreversible pulpal damage, silver diamine fluoride (SDF) can prevent pain, sepsis, and the need for extractions.
- SDF solution of 38% is more effective than lower concentrations, and biannual application is more effective than yearly application.
- SDF attracts community support and engagement with parents who do not traditionally take their children to the dentist.
- Silver-modified atraumatic restorative treatment (SMART) is an attractive alternative to the ART restoration, improving treatment outcomes.
- The Hong Kong kindergarten project indicates that children who suffer with caries can benefit from SDF.
- SDF can improve equity and accessibility to caries treatment especially for individuals from low-socioeconomic settings.

## Call to action

SDF should be part of any outreach dental programme especially for young children because the treatment approach can make dental health care more equitable and easier to access, especially in LMICs or settings where reaching a dentist is not easy.

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None disclosed.

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