Silver Diamine Fluoride:
What Is Its Place In Oral Healthcare?

Introduction / Early Childhood Caries (ECC)

The single most common chronic childhood disease is tooth decay, which is 5 times more common than asthma, 4 times more common than early childhood obesity, and 20 times more common than diabetes[1,2]. Both the American Academy of Pediatric Dentistry and The American Academy of Pediatrics view early childhood caries (ECC) as a major public health issue: recommending that caregivers and oral health care providers need to be more assertive in implementing added preventive practices that reduce caries risk in children.

Historically, ECC treatment has usually involved the drilling of the teeth to remove the decay followed by placement of restorations. In recent years thanks to a better understanding of caries etiology and pathology along with evidence from clinical trials a new perspective has evolved focused towards preventing and arresting the disease process itself. As so many of the children effected are also so young, apprehensive, uncooperative, and from disadvantaged families not able afford the cost of restorations, less invasive procedures have been considered as necessary in the battle with the ECC disease process[3].

Over the past few decades, we have seen, with the addition of fluoride application and fluoridated water, a significant decrease in caries prevalence. However, still more needs to be done. As a result, there has been movement away from the more invasive surgical approach of caries removal to a less invasive non-surgical approach to manage caries in children opening the door to the possibility of utilizing a variety of potential preventative chemotherapeutic agents. Now, with the introduction of Silver Diamine Fluoride (SDF), more attention has been brought to this inexpensive, easy-to-apply, and non-invasive treatment option in controlling pain and infection. Potentially all this could lead to an increase in access to care, improved oral health, and marked reduction in emergency care utilization[3].

SDF History and Incorporation

SDF has been utilized internationally for decades in an attempt to arrest dental caries in primary and permanent teeth. Since 1969, use in Japan, Australia, Argentina, and other nations have been reported[4,5]. In 2014, the U.S. Food and Drug Administration (FDA) cleared the use of SDF in the United States as a topical agent to decrease sensitivity[6]. Its use in arresting caries is an off-label use, defined by the FDA as an "unapproved use of an approved drug" (www.fda.gov). In the U.S. the only commercially available SDF product for dental use is Advantage Arrest™ (Elevate Oral Care, L.L.C.)[7]. Proponents have found that SDF is an effective interim therapy in reducing caries risk in primary teeth and first permanent molars[2,8].

Composition / Mechanism of Action and Pulpal Response

SDF is a colorless liquid with a pH of 10, 24.4-28.8% (253, 870 ppm) volume of silver, 5.0-5.9% fluoride (44,800 ppm), and ammonia[7,9]. This alkaline solution has been shown to aid in the formation of covalent bonds of phosphate groups onto proteins and crystallites to grow[10]. Fung et. al., have proposed that the fluoride ions in SDF mainly act on tooth structure while the silver phosphate component acts against the cariogenic bacteria[3]. SDF reacts with the enamel hydroxyapatite and results in the formation of fluorapatite [Ca10(PO4)6F2], which has been shown to be more resistant to an acidic environment than hydroxyapatite[3]. SDF has also proven to have an anti-microbial effect against *Streptococcus mutans* and *Actinomyces naeslundii* on dentin surfaces. And lastly, studies have suggested that SDF does not allow for biofilms to adhere, thereby reducing the colonization of bacteria on the enamel surfaces. The black stained layer that has been associated with arrested dentin caries shows a hard and impermeable layer of silver phosphate that protects collagen exposure[11].

Studies have shown that SDF does not induce inflammation or necrosis of the pulp and adequate tertiary dentin can be induced, therefore, making it a potentially adequate indirect pulp therapy material for deep cavities[12]. Additional studies have shown that both sodium hypochlorite and SDF can be effective agents against *Enterococcus faecalis* biofilms and therefore may be potential antimicrobial root canal irrigants[13].

According to the Manufacturer's: Application of SDF

Dosage and administration guidelines obtained from Elevate Oral Care state: "*to isolate the affected area of the tooth with cotton rolls. Clean and dry affected tooth surface. Dispense 1-2 drops of solution into a disposable dappen dish for up to 5 treated sites per patient. Transfer material directly to tooth surface with an applicator. Air dry. If needed, one or two reapplications of 1-2 drops may be administered at intervals of one week"*[14]. The material is easy to use because it takes seconds to apply, does not require air and water. In addition, patients can eat or drink immediately after application. Neither local anesthetics nor drilling are necessary. In support of manufacturer's recommendations, a study conducted in 2016 stated that SDF application every 6 months is most effective[2].

Side Effects / Contraindications and Comparisons

Patients have reported experiencing an unpleasant metal taste in their mouth. In addition, gingival and mucosal irritation has also been reported. The most prominent and lasting side effect has been the characteristic irreversible black staining of teeth after application[7]. The use of SDF has been contraindicated in children with stomatitis, ulcerative gingival conditions, and silver allergies. To date there have been no reported adverse effects for its use in treating dental caries[2].

Topical sodium fluoride (22,600ppm) application has been proven to have the ability to arrest dentin caries. Recent systematic reviews of human clinical trials have shown that SDF has greater anticariogenic effects than fluoride alone and therefore is more effective in arresting caries than fluoride varnish[15].

A study compared interim restorative treatment with glass ionomer cement (GIC) versus SDF application in primary teeth. Results showed equally efficient initial caries arrest and a decrease in active caries, but a significantly greater suppression in SDF applied teeth[16].

Conditioning with 38% SDF before placement of a restoration of GIC and/or composite has been found to aid in resistance of secondary caries formation[9].

Billing Code Procedure

SDF was approved by the Code on Dental Procedures and Nomenclature Code Maintenance Commission under D1354 as an "interim caries arresting medication application". The definition is: "Conservative treatment of an active non-symptomatic carious lesion by topical application of a caries arresting or inhibiting medicament and without mechanical removal of sound tooth structure"[5].

Conclusion and Questions To Be Considered

SDF has the potential to be an efficient and innovative approach that it is safe and effective in caries control and it meets the World Health Organization Millennium Goals and fulfills the U.S. Institute of Medicine's criteria for 21st-Century medical care[10].

Clearly SDF has significant potential to change the conventional surgical dental paradigm to oral healthcare in our country, as well as, to facilitate access to such care. But what will be the cost and gain for our patients and practices? The purpose of this white paper is to form the foundation for further interaction and discussion for our colleagues as we consider the safe and efficacious use for this new material. As we deliberate upon: "What Is Its Place In Oral Healthcare?"

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