SDF
Silver Diamine Fluoride for Caries Control

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Dental caries and limited access to dental care are major public health problems for low-income families.

Dental caries is the most prevalent untreated chronic and INFECTIOUS disease of children.

In 2009, more than 16 million Medicaid enrolled children (56%) received no dental care.
- Only ~10% of Florida’s dentists participate in Medicaid.
- Only ~10% of children under the age of 6 receive any dental services.

Untreated decay can cause pain, infection, malnutrition, poor general health, missed school days etc.

Nonsurgical management of caries disease!
Indications for SDF Treatment

- Arrest/slow down progression of carious lesions to eliminate/reduce pain and infections
- Extreme caries risk
- Young uncooperative children
- Patients without access to dental care
  - Children from disadvantaged families
  - Community-based programs
  - Institutionalized individuals
- Dentin hypersensitivity
Mechanism of Action of SDF

- 38% SDF contains ~44,800 ppm fluoride and ~253,870 ppm Ag
- Both fluoride and silver ions contribute to mechanism of action
  - Silver acts as an anti-microbial agent killing bacteria and preventing the formation of new biofilm, while the fluoride acts to prevent further demineralization
- **SDF** $\text{AgF(NH}_3\text{)}_2 + \text{hydroxyapatite} \text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2 = \text{Calcium fluoride} \text{CaF}_2 + \text{silver phosphate} \text{Ag}_3\text{PO}_4 + \text{NH}_4^+ + \text{OH}^-$
  - **Formation of fluorapatite** $\text{Ca}_5(\text{PO}_4)_3\text{F}$ !
- SDF inhibits dentin demineralization, preserves collagen and inhibits collagen breakdown, increases dentine hardness

Yamaga et al. 1972
Mei et al. 2013
Mechanism of Action of SDF

- SDF has antimicrobial properties
- Silver ions can bind with bacterial cell walls and disrupt membrane and enzyme functions causing death of bacteria
- In Vitro studies:
  - Silver ions reduces acidogenicity of dental plaque
  - Silver ions inhibits bacterial DNA replication
  - Silver ions kill bacteria and inhibit S mutans growth

Coward et al., 1973; Bragg & Rainnie 1974; Russell & Hugo 1994, Oppermann et al., 1980, Wysor & Zollinhofer 1972
• SDF treated dentin exhibits a smooth surface with few dentine collagen fibers exposed
• Control surface is porous and rough
<table>
<thead>
<tr>
<th>Study</th>
<th>N (age)</th>
<th>Duration/Intervention 38% SDF</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chu et al. 2002</td>
<td>375 children at baseline - 308 completed</td>
<td>Duration 30 mo</td>
<td>Mean # of arrested carious surfaces</td>
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<tr>
<td>China</td>
<td>(3-5 yrs) Max ant teeth Mean dmfs 4.66 Low F</td>
<td>1. Remove caries then annual SDF</td>
<td>1. 2.5</td>
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<td>2. Annual SDF</td>
<td>2. 2.8</td>
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<td>3. Remove caries then NaF every 3 mo</td>
<td>3. 1.5</td>
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<td>4. NaF every 3 mo</td>
<td>4. 1.5</td>
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<td>5. Water (cnt)</td>
<td>5. 1.3 p&lt;0.001</td>
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<td>PF% for arrest/prevention</td>
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<td>96/84</td>
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<td>122/70</td>
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<td>14/44</td>
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<td>21/56</td>
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<tr>
<td>Llodra et al. 2005</td>
<td>452 children at baseline 373 completed (~6 yrs)</td>
<td>Duration 36 mo</td>
<td>Mean # of arrested carious surfaces</td>
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<tr>
<td>Cuba</td>
<td>Primary canines, molars Permanent 1st molars/ Low F</td>
<td>1. Biannual SDF</td>
<td>1. 2.8</td>
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<tr>
<td></td>
<td></td>
<td>2. Cnt</td>
<td>2. 1.8 p&lt; 0.05</td>
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<td>PF% for arrest/prevention</td>
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<td>56/79 (prim)</td>
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<td>100/64 (1st molars)</td>
</tr>
<tr>
<td>Zhi et al. 2012</td>
<td>212 children at baseline 181 completed (3-4 yrs)</td>
<td>Duration 24 mo</td>
<td>% of caries arrested</td>
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<tr>
<td>China</td>
<td>Dmfs 5.1±4.0/ Low F</td>
<td>1. Annual SDF</td>
<td>1. 79%</td>
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<td></td>
<td></td>
<td>2. Biannual SDF</td>
<td>2. 91% p=0.007</td>
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<td>Yee et al. 2009</td>
<td>976 children at baseline 624 completed (3-9 yrs)</td>
<td>Duration 24 mo</td>
<td>Mean # of arrested carious surfaces at 6mo/12/24mo</td>
</tr>
<tr>
<td>Nepal</td>
<td>Low F</td>
<td>1. SDF once</td>
<td>1. 4.2/3.4/2.1</td>
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<tr>
<td></td>
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<td>2. SDF once +tannic acid</td>
<td>2. 4.5/4.1/2.2</td>
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<td>3. 12% SDF once</td>
<td>3. 2.3/1.7/1.5</td>
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<td>4. Cnt</td>
<td>4. 1.6/1.3/1.0P&lt;0.001/p&lt;0.001/p&lt;0.01</td>
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<tr>
<td>Zhang et al. 2013</td>
<td>277 elderly 227 (60-89 yrs)</td>
<td>Duration 24 mo</td>
<td>Mean # of arrested carious surfaces</td>
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<td>Hong Kong</td>
<td></td>
<td>1. Annual SDF +OHI+OHE</td>
<td>0.33</td>
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<td></td>
<td></td>
<td>2. Annual SDF+ OHI</td>
<td>0.28</td>
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<td></td>
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<td>3. OHI</td>
<td>0.04 p=0.006</td>
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</tbody>
</table>
# Evidence for SDF

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<tr>
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<th>PF for SDF = 39%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liu et al. 2012</td>
<td>501 children at baseline 485 completed (9 yrs) fissures</td>
<td>24 mo duration 1. Sealant 2. Biannual NaF 3. Annual SDF 4. Cnt</td>
<td>% of decayed fissure sites 1. 1.6% 2. 2.4% 3. 2.2% 4. 4.6%</td>
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<td>Southern China</td>
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<td>Tan et al. 2010</td>
<td>306 elders at baseline 203 completed (79 yrs) Exposed roots</td>
<td>Duration 3 yrs 1. Annual SDF 2. NaF every 3 mo 3. CHX every 3 mo</td>
<td>Mean # of new lesions 1. 0.7 2. 0.9 3. 1.1</td>
<td>1. 71% 2. 64% 3. 57%</td>
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<td>HongKong</td>
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<tr>
<td>Monse et al., 2012</td>
<td>704 children (6-8 yrs) Daily F toothpaste program 1st molars</td>
<td>Duration 18 mo 1. SDF once 2. GIC sealant once 3. Cnt</td>
<td>Caries increment F toothpaste Non-F 1. 0.09 1. 0.12 2. 0.01 2. 0.06 3. 0.08 3. 0.17</td>
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<td>Philippines</td>
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</table>
SDF

- In 2014, FDA cleared SDF in US for the treatment of dentinal hypersensitivity
- Off-label use for caries treatment
- In 2015, 1 product available in US market: **Advantage Arrest**, by Elevate Oral Care
SDF CDT Codes

D1208 - Topical application of fluoride
“SDF is categorized as a fluoride and can be used to treat site-specific locations. It's application and effect is very different than most fluorides, but the off-Label indication is acceptable for this code use.”

D 9910 - Application of a desensitizing medicament, per visit
“SDF is indicated for dentinal hypersensitivity treatment and can be used to treat site-specific locations.”

D1999 - Unspecified preventive procedure by report

In 2016 there will be a new CDT code for the use of caries arresting medicaments; the off-label use of Advantage Arrest.

D1354 - Interim caries arresting medicament application
"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."
Procedure for SDF Use

• Plastic-lined cover for counter, plastic-lined bib for the patient.
• Standard Personal Protective Equipment (PPE) for the provider and the patient.
• 1 drop of SDF into a glass or plastic dish.
SDF application

• Remove excess saliva
• Isolate with gauze or cotton rolls.
  • rubber dam optional.
• Apply petroleum jelly to gingiva near affected areas.
• Dry the affected areas gently.
• Immerse the micro-sponge in a drop of SDF (a drop treats ~5 sites).
• Apply to the lesion with micro-sponge.
• Allow to absorb for 1 min.
• Rinse with water.
• Consider pt cooperation, consent, protection (gloves, safety eyewear etc).
• 1-2 reapplications at intervals of 1 week (UCSF)
• Recall after 3-6 wks, 3-6 month intervals (Elevate)
• 1-2 x/year (most studies)
Safety of SDF

- 80 years of use in Japan, ~12 clinical trials: No significant adverse effects or acute toxicity cases (no studies on toxicity on children)
- No severe pulpal damages have been reported - may irritate pulp in deep lesions
- Mild gingival irritation can occur (vaseline can be used over gingival margins to prevent irritation)
- No evidence of fluorosis if used properly (Health Dept. of Western Australia; Neesham, 1997)
- Hypothetical risk due to high conc. of F- 44,800 ppm

Contraindications:
- Silver allergy
- Ulcerative gingivitis
- Stomatitis
Considerations for SDF Use

- No excavation, decay removal or anesthesia needed
- Do not use on exposed pulp
- Does not stain sound tooth tissue
- Darkening of the lesions occur over 24 hrs and many increase over a week
- SDF can stain the skin which will clear in 2-3 weeks without treatment
  - Wear gloves and advise children not to spit or rub the saliva over their face/skin
- SDF can permanently stain surfaces, clothes
- Protect eyes
- First recall within 3-6 weeks
- Set recall appointments based on the risk level with high risk patients at 3 month interval
- Re-apply if lesion is not arrested
Considerations for SDF Use

- Do not use other F products at the same appt
- May decrease adhesion to composites
- No post op instructions, pt can eat and drink
- Saturated Solution of Potassium Iodide (SSKI, various sources) can be used after SDF to decrease color changes.
- **Potassium iodide not for pregnant or breastfeeding women**
- Consent!
- NaF varnish containing 2.26% F (22,400ppm) applied topically to the teeth
- Safe, easy and efficient application
- 2-4 x/year applications
THANK YOU!

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