What works?
Clinical effectiveness of silver ion products

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Silver Compounds

Table 1 - Use of silver compounds for caries management in dentistry.

<table>
<thead>
<tr>
<th>Period</th>
<th>Advances</th>
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<tbody>
<tr>
<td>Up to 1900</td>
<td>AgNO₃ used in caries management</td>
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<tr>
<td>1917</td>
<td>Howe’s solution (AgNH₃NO₃) invented and used up to 1950s</td>
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<td>1970s–1990s</td>
<td>AgF used alone and combined with SnF₂ in clinical studies in Western Australia</td>
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<td>1970s</td>
<td>Development of SDF in Japan supported by Central Pharmaceutical Council of the Ministry of Health and Welfare</td>
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<td>1990s</td>
<td>SDF was recommended for young children in Brazil</td>
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<td>2000s</td>
<td>Randomized controlled clinical trials on SDF and other preventive treatments</td>
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<td>2000s</td>
<td>Addition of silver particle into restorative materials</td>
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</tbody>
</table>

Rosenblatt et al., 2009

Peng et al., 2012
38% (44,800 ppm F) Silve Diammine Fluoride-SDF solution (e.g., Fluoroplat, Safluoride, Saforide; ammonia and AgF combined to form a diammine silver ion complex Ag(NH$_3$)$_2^+$; claimed to be more stable than AgF, and can be kept at constant concentration for a longer time; pH=8-9)

- **Antibacterial**
- **When in contact with dentin:** Ag$_3$PO$_4$ (weakly soluble; turns black with sunlight or reducing agents) = Black, hard layer
- **Metallic taste; transient gingival and mucosal irritation** (Llodra et al., 2005)
- **To counter stain:** KI (no clinical trial; in vitro suggests same effect on biofilm, Knight et al., 2005)
- **Low cost, easy to use**
- **Arrest caries in primary teeth of preschool children**

\[ Ca_{10}(PO_4)_6(OH)_2 + Ag(NH_3)_2F \rightarrow CaF_2 + Ag_3PO_4 \]
\[ + \quad NH_4OH \quad \text{Alkaline environment} \]
<table>
<thead>
<tr>
<th>Authors (Year)</th>
<th>Target</th>
<th>Surface</th>
<th>Groups</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chu et al. (2002) (Lo et al., 2001 reported 18 month data)</td>
<td>Children 3-5 (China); N=375</td>
<td>Cavitated lesions in anterior primary teeth (RCT; 30 months; 1 blinded calibrated examiner; exams every 6 months; outcome= caries arrest-hardness)</td>
<td>5 groups: 38% SDF annually (with or without excavation) vs. FV applied every 3 months (with or without excavation) vs. control (no treatment)</td>
<td>SDF groups had higher caries arrest rates than those of NaF groups and control (respective mean numbers of arrested caries tooth surfaces in the five groups were 2.5, 2.8, 1.5, 1.5 and 1.3). All arrested lesions, regardless of group, were darker. SDF arrests lesions better than FV and nothing (1x/year: PF ~ 70-84%; better than FV ~44-56%). No need for prior excavation.</td>
</tr>
</tbody>
</table>

Comments: 1- Ethical concern regarding the no treatment, and 2- only applicable to anterior teeth. 3- But study quality good; low risk of bias. 4-“In this study, only the upper primary incisors and canines were involved, because caries in the three- to four-year-old Chinese children was mainly found in these teeth”
Llodra et al. (2005)

**Target**
Children 6-15 (Cuba); N=452
Low F= 0.09ppm
dmfs: 3.5-3.6
(primary teeth data were gathered for the surfaces of only canines and molars. In permanent teeth, data were gathered only on first molars)

**Surface**
Cavitated lesions of primary and permanent teeth and occlusal surfaces of any first permanent molars that had erupted.
(RCT, 36 months; 2 blinded calibrated examiners; exams every 6 months; outcome: caries arrest-hardness

**Groups**
38% SDF every 6 months for 3 min (no tissue removal in primary teeth; yes for permanent teeth) vs.
nothing

**Results**
Mean # of new decayed surfaces in primary teeth during the study was 0.29 in the SDF group vs. 1.43 in controls.
The mean of new decayed surfaces in first permanent molars was 0.37 in the SDF group vs. 1.06 in controls.

With respect to the therapeutic effect of SDF (arrest of caries), around 77% of treated active lesions became inactive, both in primary teeth and in first permanent molars.

In the SDF group, practically all (97%) of inactive lesions presented black stain at the end of the follow-up.

A hypothetical risk attributed to SDF is its possible toxicity to the pulp. This concern was not supported by the present results (i.e., there was a similar incidence of pulpal lesions between the groups, in both deciduous and permanent teeth).

**Conclusion:**
1) 2x/year better than nothing in prevention and arrest
2) Preventive effect higher in primary than permanent teeth (primary teeth PF 79% and 64% in permanent teeth)

(Comments: “In the present study, the baseline level of caries was much higher in deciduous teeth (mean of > 3 surfaces with caries) than in first permanent molars (0.3 surfaces with caries), which may explain the greater efficacy of the SDF solution in the deciduous dentition.”)
Yee et al. (2009)  
**Target**  
Children 3-9 (Nepal); N=976  
Low F=0.03ppm  
dmft: 4.6  
**Surface**  
Active cavitated lesions in primary teeth (anterior and posterior)  
**Groups**  
1 application (2min):  
38% SDF with tannic acid made from tea as a reducing agent vs.  
38% SDF vs.  
12% SDF vs.  
nothing (control)  
**Results**  
# of arrested lesions was significantly higher in groups treated with 38% SDF than 12% SDF and control group.  
No difference between 38% SDF alone and the group treated with 38% SDF + tannic acid (to accelerate deposition of silver phosphate).  
There was no effect of the 12% SDF alone application  
**Conclusion:**  
1) 38% more effective than 12% SDF  
2) Effectiveness decreases over time
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<tr>
<td>Zhi et al. (2012)</td>
<td>Preschool Children 3-4 (China), N=212 Mean dmft: 5.1</td>
<td>Cavitated active dentine lesions in primary teeth (RCT, 3 years, exams every 6 months, 1 calibrated blinded examiner)</td>
<td>38% SDF annually vs. SDF biannually vs. Glass ionomer filling annually</td>
<td>Caries arrest rates were 79%, 91% and 82%, respectively (p=0.007). <strong>Conclusion:</strong> 1) Annual application of either SDF solution or high fluoride-releasing glass ionomer can arrest active dentine caries. 2) Increasing the frequency of application to every 6 months can increase the caries arrest rate of SDF application.</td>
</tr>
</tbody>
</table>

(Comments: blinding of filling impossible; study quality good; low risk of bias)
CONCLUSIONS

- Evidence limited
- Caries removal does not offer any significant benefit in arresting caries
- 38% SDF can arrest caries better than 12%
- Biannual application better than annually
- Application of 10% SnF₂ or tannic acid showed no additional benefit in acceleration of or increase in uptake of SDF by the tooth surface