Silver Diamine Fluoride: Back to the Future
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Course Objectives
- Explain the history of silver nitrate and silver diamine fluoride (SDF)
- Describe what SDF is and how it works
- Discuss the safety and indications for use of SDF
- Present protocols for SDF application, available products, and follow-up recommendations
- Review CDT codes and recent legislation

History of Silver Nitrate
- Silver Fluoride (AgF)
  - Used in Japan for approximately 900 years
  - Intended for cosmetic blackening
  - Unintended effect was caries prevention
- Silver Nitrate
  - Caries arrest protocols documented in the 1800s
  - 1891: 87 of 142 treated lesions were arrested
Early 1900’s in the U.S.

- G.V. Black
  - "Father of Modern Dentistry"
  - In 1906, Black documented protocols for silver nitrate
  - Used to treat troops deployed in World War I
  - Side effect was that the silver nitrate made teeth brittle (loss of Calcium)
  - In 1908, Black traveled to Colorado Springs to learn about "Colorado brown stain", which later proved to be the result of fluoride and led to a reduction in caries

- Percy Howe
  - First research director at Forsyth Institute in Boston and ADA President 1928-1929
  - Became well known for his successful treatment of caries with silver nitrate, that other dental professionals began calling it "Howe's Solution"
  - Advertised in JADA

Water Fluoridation

- In the 1950’s, water fluoridation became the focus of prevention and interest in silver nitrate faded.

Silver Diamine Fluoride

- Silver Diamine Fluoride (SDF) Development in Japan
  - Built upon AgF success
  - Added remineralization properties of fluoride to antimicrobial properties of silver nitrate
  - NH3+ added to silver fluoride for stabilization
  - Mizuho Nishino researched SDF for PhD from 1965-1969
  - Nishino’s research was published in the Journal of Osaka University Dental Society in 1969
  - SDF product by the name Saforide was released
  - Over 2 million bottles sold. Zero adverse outcomes documented.

Recent Developments in the U.S.

- FDA Approval in U.S.
  - 2014: FDA approval for dental sensitivity
  - 2015: Elevate Oral Care releases Advantage Arrest (SDF)
  - 2016: Breakthrough Therapy Designation by FDA
  - 2018: SD North America releases Riva Star (SDF+KI)

- Publicity and Popularity
  - PBS - January 2016
    - [Link](http://www.pbs.org/newshour/show/this-new-treatment-could-make-your-next-trip-to-the-dentist-more-bearable)
  - JADA - August 2016
    - [Link](https://jada.ada.org/article/S0002-8177(18)30232-0/abstract)
Science Behind SDF

- **Formulation**
  - 25% silver (antimicrobial)
  - 8% ammonia (solvent)
  - 5% fluoride (remineralization)

  *Twice the concentration of fluoride is used, but less than half the volume compared to fluoride varnish, so overall fluoride exposure is less.*

  *The rest of the solution is made up of water. In the Elevate Advantage Arrest, there is also <1% blue dye which dissipates as the solution dries.*

  - Silver nitrate alone can make teeth brittle
  - Formulations with fluoride help strengthen enamel and are optimal for long term outcomes

Multiple Benefits

- Arrests caries
- Prevents caries
- Decreases dentinal sensitivity

Caries Arrest

- **Silver Ions**
  - Bactericidal
  - Prevents bacterial growth
  - Deactivates proteins

  **How Silver Ions Work**

  *They inhibit growth of the bacteria by deactivating their proteins.*

Caries Prevention

- **Direct**
  - remineralizes dentin lesions
  - increases lesion hardness
  - prevents demineralization
  - SDF penetrates dentin up to 150 microns

- **Indirect**
  - can inhibit plaque bacteria
  - reduces plaque and bacterial formation
  - "Zombie Effect" Silver kills bacteria, kills active bacteria
  - Silver-kill bacteria kill active bacteria

[Link to article: https://www.sciencemag.org/news/2015/05/silver-turns-bacteria-deadly-zombies]
Efficacy

- Caries arrest
  - ~90% arrest with 2/year application.
  - 40-80% arrest with 1/year application.

- Caries prevention
  - 25-70% prevention, outperforms everything by far.
    - Null variant is ~20% effective with 1-4 applications/year

Indications for Use (and limitations)

- Indications
  - Extreme caries risk (symptomatic, severe ECC)
  - Behavior or medical management challenges
  - More lesions than treatable at 1 visit
  - Difficult to treat lesions
  - Patients without access to care
  - Patients looking for minimally invasive treatment options

- Contraindications and limitations
  - Possible concerns with silver allergy
    - Though some research suggests this is not a concern because it contains silver ions
  - May sting ulcerated gingiva
    - Can use petroleum jelly to protect gingiva when needed
  - Do not use if there is exposed pulp in lesion
    - Can cause sensitivity and “zinging” feeling
    - No adverse reports in over 80 years in Japan

COVID-19 and Minimally Invasive Options

- CDC recommends that minimally invasive and non-aerosol procedures be prioritized during this time (and that is also stated in the PHO)

- During this time:
  - SDF can be applied without aerosols
  - ITR can be placed without a handpiece, or other aerosols

- Optimize schedules (for dentist OR hygienist) by:
  - Scheduling more patients for less time
  - Addressing treatment that was left undone for the past 3 months and buy-time for treatment plans to be completed
  - Minimize aerosols in the office
  - Consider remote/community-based options for SDF/ITR to keep patients from needing to come in the office as many times, or for as long of appointments
Safety

- Silver
  - 10% view
  - No known terminal risks of ingesting silver
  - dosage: limit use to the dots

- 25% silver
  - Higher applied dose (1 permanent tooth) = 1.27 mg
  - 1 lid treatment to reach maximum exposure

- Toxicity
  - Max dose of 1 drop per 10 kg (22 lbs) body weight with weekly intervals
  - This value is conservative (the lethal subcutaneous dose (LD50) is 380 mg/kg and gives a five-hundredfold safety margin (UCSF protocol))

- SDF Side Effects
  - Possible oral or nasal mucosal lesion - will disappear in 48 hours
  - It WILL stain lesion black (caused by the silver precipitating out of the solution)

- Other
  - Exposure of the lining of the oral cavity or the pharynx. Proper research is available to show that
    - SDF is not toxic, and the staining does not disturb oral function.

Getting Started

- Informed Consent
  - Separate consent is not REQUIRED, but since the products and procedure are
    "new" to most people, a consent is helpful for patients/parents to fully understand
  - An extra measure to ensure treatment option discussion has covered all the
    important points
  - Should include color photos so that patients/parents can claim later that they
    were not aware of the staining/color change that would happen
  - Sample consent form – www.coshra.org/legal

- Basic Setup

Protocols
1. Prepare setup with proper isolation and PPE
   - Plastic-lined tray cover, cotton roll, tray, dry angle, microbrush, plastic dappen dish, 1-2 drops of SDF, fluoride varnish, mirror, fluoride spray, air/water syringe, basic kit with mirror

2. Isolate lesion(s) using cotton roll, dry angle, and/or bite block

3. Dry with air/water syringe

4. Dip microbrush in SDF from dappen dish and apply a small amount for 60 seconds.
   - Do not need to excavate caries prior to application
   - Let solution sit dry for 60 seconds. Do not dry with air/water syringe or solution will spread to
     other areas.
   - Do not light cure

5. Apply fluoride varnish
   - Paint with excess of SDF and "wax" over application site so that it does not wash away with
     saliva or altered saliva
   - You can apply with gauze if fluoride varnish is not desired

*Note: SDF will stain everything in contact; overspray, cotton rolls, mirror, tray. Be careful to isolate well and only apply
  to the lesion. Wash hands after handling SDF. Aseptic technique is not required. Healing occurs within 48 hours.
Product Comparison

<table>
<thead>
<tr>
<th>Advantage Arrest (Elevate Oral Care)</th>
<th>Riva Star (SDI)</th>
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<tbody>
<tr>
<td><strong>Cost</strong></td>
<td><strong>Unit Dose: $4 = $2 per drop</strong>&lt;br&gt;<strong>Bottle: $162/250 drops = $0.64 per drop</strong>&lt;br&gt;<strong>$8 per dose</strong></td>
</tr>
<tr>
<td><strong>Storage &amp; Shelf Life</strong></td>
<td><strong>Room Temperature: 3 years</strong>&lt;br&gt;<strong>Refrigerated: 2 years</strong></td>
</tr>
<tr>
<td><strong>Distribution</strong></td>
<td><strong>Direct Only (elevateoralcare.com)</strong>&lt;br&gt;<strong>Dental Distributors Only (Schein, Patterson, Benco, etc.)</strong></td>
</tr>
<tr>
<td><strong>Stains Teeth</strong></td>
<td><strong>Yes</strong>&lt;br&gt;<strong>Yes</strong></td>
</tr>
<tr>
<td><strong>Application Technique</strong></td>
<td><strong>One-Step</strong>&lt;br&gt;<strong>Two-Step (SDF + KI)</strong></td>
</tr>
<tr>
<td><strong>Special Features</strong></td>
<td><strong>Tinted blue so that clinician can see area where solution has applied</strong>&lt;br&gt;<strong>Additional step of applying potassium iodide can decrease staining</strong></td>
</tr>
<tr>
<td><strong>Other Considerations</strong></td>
<td><strong>KI can lower zone of inhibition. Not intended for preventive use, and instructions say to place GI restoration immediately after use.</strong>&lt;br&gt;<strong>Indicated for use on adults over age 21</strong></td>
</tr>
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Photos from Dr. Jeanette Maclean

Follow-Up

Schedule patient for follow up visit 2-4 weeks after initial application

- Ensure that lesion is hard and dark black. If not, reapply.
- Place restoration in this visit, if applicable.
- Best results if SDF is reapplied at least twice per year for at least 2 years
- Unless restoration is placed over application site
- SDF treatment can be the definitive treatment, or part of a larger treatment plan, depending on patient’s needs and desires.

Additional treatment options:

- Can be used to treat interproximal lesions using Superfloss
- Can be used in combination with other restorations, ideally glass ionomer
- SMART technique
- Can be placed same day or at future appointment
- Can be used for primary crowns (Hall Crowns)
CDT Procedure Codes and Billing

- D1354 – interim caries arresting medicament application
  - When SDF is used primarily to arrest caries, either prior to a restoration placement, or as a way to “buy time” due to cooperation limitations of patients, or because of medical, behavioral, and physical, or financial limitations.
  - Intended to be used “per tooth”
  - RECOMMENDED PROCEDURE CODE!

- D1208 – topical application of fluoride, excluding varnish
  - When SDF is applied to high risk sites such as hypoplastic molars, root surfaces, furcations, restoration margins, unsealed pits and fissures, or to prevent new or secondary lesions.

- D9910
  - When SDF is used to treat dentinal hypersensitivity

Colorado Laws and Rules Regarding SDF

- HB 18-1045
  - Signed into law March 2018
  - Full text: https://leg.colorado.gov/bills/hb18-1045

- Rule XXVI
  - Approved by Colorado Dental Board in June 2018
  - Effective August 14, 2018 (Revised July 2019)

Colorado Laws and Rules Regarding SDF (cont.)

- Requirements for dental hygienists to use SDF in Colorado
  - Successfully complete course
    - Minimum of 1 hour, “live and interactive”
    - Approved by ADA/PACE, ADA/CERP, CODA accredited institution, or as state law.
    - Carry professional liability insurance, as specified in 12-35-141
  - If using under indirect or telehealth supervision, have a written collaborative agreement with supervising dentist.
    - Visit www.codha.org/legal for examples of collaborative agreement

- Supervision required
  - Direct
  - Indirect
  - Telehealth

- SDF section of Practice Act is going through Sunset Review process and will be revised in 2021 legislative session.
Resources

- Dr. Jeanette Maclean DDS
  - www.kidsandbraces.com
  - Anterior application of SDF - https://www.youtube.com/watch?v=zxlvbhUx3QE&t=47s
  - Dentaltown Webinars
  - More videos - https://www.youtube.com/channel/UCuJ6qgHP6JxaIqmSe3HSLmQ
  - UCSF Protocol for Caries Arrest Using Silver Diamine Fluoride: Rationale, Indications, and Consent
    - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4778976/
  - Research
    - “Silver Diamine Fluoride: a caries ‘silver-fluoride bullet’”
    - “Effectiveness of silver diamine fluoride and sodium fluoride varnish in arresting dentin caries in Chinese preschool children.”
      - http://hub.hku.hk/bitstream/10722/53198/2/80787.pdf?accept=1
  - Sample Consents and Collaborative Agreements
    - www.codha.org/legal
  - Tray Set Up and Procedure (video)
    - https://www.youtube.com/watch?v=SLJTfniWtE4&feature=youtu.be

Resources (cont.)

- ADA Articles
    - https://jada.ada.org/article/S0002-8177(18)30232-0/fulltext
  - “Systematic Review of SDF Efficacy and Application in Older Adults”
    - https://www.ada.org/~/media/ADA/Public%20Programs/Files/MPRG_Systematic_Review_of_SDF_Efficacy_and_Application_in_Older_Adults.pdf?la=en
  - Sample Consents and Collaborative agreements
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  - Tray Set Up and Procedure (video)
    - https://www.youtube.com/watch?v=SLJTfniWtE4&feature=youtu.be

Contacts

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Questions?