Controversies Regarding Systemic and Topical Fluoride

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Ava Roberts Course
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Controversies

- Systemic Route/Topical Effect?
- F Mechanisms?
- Systemic F Supplements?
- Optimally F Water to Make Infant Formula?
- EPA Reducing the Level of F in Drinking Water?
- Age to Start Brushing Teeth with F Toothpaste?

Topical F
  - Who should get it?
  - How much?
  - Prophy before F?

Systemic vs. Topical

- Fluoride incorporated throughout unerupted tooth development (pure systemic)
- Fully developed, but unerupted tooth bathed in fluoride for months before eruption (topical)
- Fluoride released into salivary and crevicular fluids to affect erupted teeth (topical)

Systemic vs. Topical

Fluoride Rich Zone

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Fluoride Mechanism

- Reduces solubility of HAP
- Remineralizes affected enamel
- Fluoride reservoirs in enamel (CaF$_2$ and fluoridated hydroxyapatite) liberated during carious attack
- Antimicrobial effect
Remineralization – White Spot Lesion with Intact Surface

F is a “catalyst” for remineralization

Remineralized Lesions on Maxillary Anterior Primary Primary Teeth

Fluoride’s Effect on Cell Metabolism

Fluoride Effect on Cell Metabolism

\[
\text{Glucose} \rightarrow \text{(Glucose)}_{n+1} \rightarrow \text{ADP-glucose} \rightarrow \text{ADP} \rightarrow \text{glucose ATP} \rightarrow \text{Glucose-6-P} \rightarrow \text{Lactic acid}
\]
Antibacterial Properties of SnF$_2$ vs NaF

Tin Binding to Plaque Bacteria

Silver Diamine Fluoride

Indication and Usage: Treatment of dentinal hypersensitivity. For use in adults over the age of 21.
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Original Systemic Fluoride Regimen
1950s–1979

<table>
<thead>
<tr>
<th>Age</th>
<th>&lt; 0.3 ppm</th>
<th>&gt; 0.6 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth – 3 yrs</td>
<td>0.5 mg F</td>
<td>0.0 mg F</td>
</tr>
<tr>
<td>3 – 6 yrs</td>
<td>1.0 mg F</td>
<td>0.0 mg F</td>
</tr>
</tbody>
</table>

Effects of Fluoride Supplementation on Permanent Teeth

<table>
<thead>
<tr>
<th>Fluoride Supplement</th>
<th>Mean DFS Score</th>
<th>Very Mild Fluorosis</th>
<th>Mild Fluorosis</th>
<th>Moderate Fluorosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluoride Supplement</td>
<td>1.57</td>
<td>34.0</td>
<td>18.0</td>
<td>14.0</td>
</tr>
<tr>
<td>No Fluoride Supplement</td>
<td>7.93</td>
<td>3.2</td>
<td>1.1</td>
<td>0</td>
</tr>
<tr>
<td>F Water</td>
<td>3.16</td>
<td>21.7</td>
<td>8.7</td>
<td>2.2</td>
</tr>
</tbody>
</table>


Fluoride Dosage Relative to Age and Fluoride Content of Water (1994 – present)

<table>
<thead>
<tr>
<th>Age</th>
<th>&lt; 0.3 ppm</th>
<th>0.3–0.6 ppm</th>
<th>&gt; 0.6 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 mo – 3 yrs</td>
<td>0.25 mg F</td>
<td>0.0 mg F</td>
<td>0.0 mg F</td>
</tr>
<tr>
<td>3 – 6 yrs</td>
<td>0.50 mg F</td>
<td>0.25 mg F</td>
<td>0.0 mg F</td>
</tr>
<tr>
<td>6 – 16 yrs</td>
<td>1.0 mg F</td>
<td>0.50 mg F</td>
<td>0.0 mg F</td>
</tr>
</tbody>
</table>

Only for children at caries risk, CDC, 2001
Issues with Fluoride Supplements

- Prescribers do not:
  - Test water supplies for fluoride
  - Consider the caries risk status
  - Weigh risks vs benefits
- Confusion exists on how to prescribe supplements for time spent away from home
- Fluorosis perhaps due to spikes in the plasma fluoride levels
- Poor compliance with administration; parents of high risk children are less likely to comply

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Fluoride Content in Formula, 1978

<table>
<thead>
<tr>
<th>Formula</th>
<th>Fluoride Content</th>
<th>Fluoride Content with Addition of Equal Parts of Water (1 ppm F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enfamil, ready to feed</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Enfamil, concentrate</td>
<td>&lt; 0.1</td>
<td></td>
</tr>
<tr>
<td>Similac, ready to feed</td>
<td>0.86</td>
<td></td>
</tr>
<tr>
<td>Similac, concentrate</td>
<td>0.13</td>
<td>0.52</td>
</tr>
<tr>
<td>Isomil, concentrate</td>
<td>&lt; 0.1</td>
<td>0.85</td>
</tr>
<tr>
<td>SMA, concentrate</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>Human breast milk</td>
<td>&lt; 0.1</td>
<td></td>
</tr>
</tbody>
</table>


Infant Formula Issues

**Powdered Formula Reconstituted with Fluoridated Water**

Optimal fluoride dose = 0.05 mg/kg

**Case study:** 1-year-old child, weighing 10 kg, consumes 32 ounces (1 liter) of powdered formula/day that is reconstituted with optimally fluoridated water – 1.0 ppm F.

Ingestion of 1 liter of formula at 1 ppm F = 1 mg of fluoride/day

1 mg F per day/10 kg body weight = 0.1 mg/kg
Risk of Experiencing Fluorosis
Use of Infant Formula vs. Breast or Cow’s Milk

Risk of Experiencing Fluorosis
Use of Infant Formula vs. Breast or Cow’s Milk

Plasma Fluoride Concentration Curves
fasting or milk

Prevalence of Enamel Fluorosis
by Age and Severity of Fluorosis


Mild-Moderate Fluorosis

CDC’s Recommendation

Parent who are concerned about the effect that mixing their infant’s formula with fluoridated water may have in developing enamel fluorosis can lessen this exposure by mixing formula with low fluoride water.


HHS and EPA announce new scientific assessments and actions on fluoride

- HHS’ recommendation of 0.7 milligrams of fluoride per liter of water replaces the current recommended range of 0.7 to 1.2 milligrams.

Infant Formula Issues

Powdered Formula Reconstituted with Fluoridated Water

Optimal fluoride dose = 0.05 mg/kg

Case study: 1-year-old child, weighing 10 kg, consumes 32 ounces (1 liter) of powdered formula/day that is reconstituted with optimally fluoridated water – 1.0 (0.7) ppm F.

Ingestion of 1 liter of formula at 1 (0.7) ppm F = 1 (0.7) mg of fluoride/day

1 (0.7) mg F per day/10 kg body weight = 0.1 (0.07) mg/kg

Department of Health and Human Services. Public Health Reports 2015;130:1-14
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Fluoridated Toothpaste Doses for Preschoolers

“Smear”– under 2(3) yrs.
“Pea-sized”– 2(3)-5 yrs.

NOTE: JADA Feb. 2014 -- “smear” should be continued until age 3

Topical Fluoride

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>&gt; 6 Years</th>
<th>6-18 Years</th>
<th>18+ Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Moderate</td>
<td>Varnish or foam at 6 month intervals</td>
<td>Varnish or gel at 6 month intervals</td>
<td>Varnish or gel at 6 month intervals</td>
</tr>
<tr>
<td>High</td>
<td>Varnish or foam at 3 or 6 month intervals</td>
<td>Varnish or gel at 3 or 6 month intervals</td>
<td>Varnish or gel at 3 or 6 month intervals</td>
</tr>
</tbody>
</table>

Professional Fluoride Treatment

- Either 1.23% APF, 2% NaF or 2.3% F varnish
- Four minute application time
- Not to eat or drink for 30 minutes
- Minimum amount of fluoride and saliva ejector
- No need to precede with pumice prophylaxis

Meta-analysis of 2.26% fluoride varnish on primary teeth [d(e/m)fs]

The panel concluded with moderate certainty that there is a small benefit of 2.26% fluoride varnish application at least twice per year for caries prevention in the primary teeth among children aged 6 months to 8 years.

Meta-analysis of 2.26% fluoride varnish on permanent teeth [DMFS]

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Professional Fluoride Treatment

- Either 1.23% APF, 2% NaF or 2.3% F varnish
- Four minute application time
- Not to eat or drink for 30 minutes
- Minimum amount of fluoride and saliva ejector
- No need to precede with pumice prophy

Fluoride Dose Using Trays

Small tray with 5 ml fluoride

Large tray with 10 ml fluoride
Fluoride Foam and Tray with Fluoride Foam

Density = 1/10 that of gels

Fluoride Varnish

Professional Fluoride Treatment

- Either 1.23% APF or 2% NaF
- Four minute application time
- Not to eat or drink for 30 minutes
- Minimum amount of fluoride and saliva ejector
- No need to precede with pumice prophylaxis

Enamel Fluoride Levels After Abrasion
Enamel Fluoride Levels after Prophy

Fluoride Concentration in parts per million


Fluoride Protocol for Children

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>0-2 years</th>
<th>3-5 years</th>
<th>&gt;6 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Risk</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
</tr>
<tr>
<td>Moderate Risk (parent engaged)</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
</tr>
<tr>
<td>Moderate Risk (parent not engaged)</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
</tr>
<tr>
<td>High Risk (parent engaged)</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
</tr>
<tr>
<td>High Risk (parent not engaged)</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
<td>- Twice daily brushing with Fluoride toothpaste</td>
</tr>
</tbody>
</table>

* Need to consider fluoride levels in drinking water

** One needs to carefully weigh the risks/benefits (risk of fluorosis versus the value of caries reduction)

Meta-analysis of 1.23% prophylaxis prior to topical fluoride application

<table>
<thead>
<tr>
<th>Outcomes Measure</th>
<th>Number and type* of studies</th>
<th>Number of participants</th>
<th>Standardized Mean Difference [95% Confidence Interval] (negative favors intervention, positive favors control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent teeth data</td>
<td>2 RCT and 1 CCT</td>
<td>1363</td>
<td>0.00 [-0.11, 0.11]</td>
</tr>
<tr>
<td>Primary teeth data</td>
<td>1 RCT</td>
<td>86</td>
<td>0.03 [-0.39, 0.46]</td>
</tr>
</tbody>
</table>

The panel to conclude with moderate certainty that there is no benefit from using prophylaxis paste containing fluoride applied for 4 minutes twice per year for caries prevention in the permanent teeth of 8-16 year olds.

The panel to conclude with low certainty that there is no benefit from using prophylaxis paste containing fluoride applied for 4 minutes twice per year for caries prevention in the primary teeth of 3-5 year olds.

(NOTE: low certainty will produce a recommendation of "expert opinion" rather than a data driven recommendation)

Effect of 0.5% Fluoride Pastes and Gels on Caries Prevalence or Increment

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>Number and type of studies</th>
<th>Number of participants</th>
<th>Standardized Mean Difference [95% Confidence Interval] (negative favors intervention)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMFT prevalence</td>
<td>1 CCT</td>
<td>236</td>
<td>-0.43 [-0.69, -0.17]</td>
</tr>
<tr>
<td>dmfs increment</td>
<td>1 RCT</td>
<td>676</td>
<td>-0.16 [-0.31, -0.01]</td>
</tr>
<tr>
<td>DMFS increment</td>
<td>6 RCT</td>
<td>2,653</td>
<td>36.8% reduction from all trials</td>
</tr>
</tbody>
</table>

0.5% fluoride gel applied professionally or supervised at school, primary teeth

0.5% fluoride gel applied professionally or supervised at school, permanent teeth

0.5% fluoride paste, permanent teeth

0.5% fluoride paste, permanent teeth
<table>
<thead>
<tr>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>The way the product is advertised</td>
</tr>
<tr>
<td>Professional strength</td>
</tr>
<tr>
<td>APF</td>
</tr>
<tr>
<td>NaF</td>
</tr>
<tr>
<td>SnF$_2$</td>
</tr>
<tr>
<td>NaF varnish</td>
</tr>
<tr>
<td>Silver diamine F</td>
</tr>
<tr>
<td>Tray or Brush-on</td>
</tr>
<tr>
<td>Prevident</td>
</tr>
<tr>
<td>Gel Kam</td>
</tr>
<tr>
<td>Weekly Rinses</td>
</tr>
<tr>
<td>Daily Rinses</td>
</tr>
<tr>
<td>Dentifrices</td>
</tr>
</tbody>
</table>

Summary

- Major fluoride mechanisms include remineralization and antimicrobial. Primarily topical affect.
- Dietary supplements are effective in reducing dental caries and should be considered for children at caries risk who drink fluoride-deficient (<0.6 ppm) water. Problems with prescriptions and compliance.
- Fluoridated toothpaste is effective in reducing dental caries in children. New recommendations is “smear” under 3; “pea-size” 3-6
- Professionally-applied topical fluoride treatments as 5% NaF varnish or 1.23% F gel preparations are efficacious in reducing caries in children at caries risk.
- 0.2% sodium fluoride mouthrinse and 1.1% NaF brush-on pastes also are effective in reducing dental caries in children.