

UBC Faculty of Dentistry

Presentation from

Professionalism and Community Service (PACS 410)

Professionally Applied Topical Fluorides

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## **GROUP 4**

**Professionally Applied Topical Fluorides**  
**DENT 410 PACS – Oral Self Care Module**  
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## I. Forms of Professional & OTC Fluoride

### 1. Professional Fluoride [1]

#### *Fluoride Gel and Foam:*

Commonly used: APF (Acidulated Phosphate Fluoride) w/ 1.23% or 12300 ppm fluoride ion; 2% NaF (Sodium Fluoride) w/ 0.90% or 9050 ppm fluoride ion

#### *Fluoride Varnish:*

Commonly used: 5% NaF (Sodium Fluoride) w/ 2.26% or 22600 ppm F-

#### *Fluoride Paste:*

Not accepted by FDA/ADA as an efficacious way to prevent dental caries

#### *Dietary Fluoride:*

Supplements: Prescription Supplement of Tablets/Lozenges w/ 1.0, 0.5 or 0.25 mg fluoride (also comes in liquid form)

### 2. OTC Fluoride:

#### *Fluoride Toothpaste:*

Commonly used: Paste with Sodium Fluoride w/ 1000 ~ 1500ppm F-

#### *Fluoride Mouthrinse:*

Commonly used: 0.05% Sodium Fluoride w/ 230 ppm fluoride ion (Supervised use: 0.20% Sodium Fluoride w/ 920 ppm F-

## II. Do OTC and Professional fluoride products achieve the same purposes?

Ultimately, the use of fluoride in any concentration or form in oral hygiene maintenance is to achieve one purpose: caries prevention [1]. There are currently three hypothesized mechanisms which may allow fluoride to fulfill its purpose:

### 1. Prevent Demineralization:

Fluoride is incorporated into enamel crystal structure to become fluorapatite [2,3]. In contrast to hydroxyapatite, fluorapatite is less soluble in the acidic environment that is typically generated by cariogenic bacteria thriving in oral plaque, thereby inhibiting the demineralization process of enamel.

### 2. Enhance Remineralization:

Fluoride can be deposited as  $\text{CaF}_2$  on dental hard surfaces [1,2,4]. Typically achieved with high-concentration topical fluoride,  $\text{CaF}_2$  deposits act as fluoride reservoirs, which release fluoride slowly, particularly during acidic episodes produced by cariogenic bacteria. The fluoride released then goes on to prevent demineralization of enamel via the mechanism mentioned above.

### 3. Anti-Cariogenic Bacteria:

Fluoride has several proposed anti-bacterial effects against cariogenic bacteria. First, research has suggested that fluoride could inhibit the glycolytic pathway by which cariogenic bacteria rely upon for normal metabolism [1,5]. The inhibition of

glycolysis would suggest a decrease in metabolic products such as lactic acid being generated, which is the main cariogenic agent. Second, it has been shown that fluoride prevents the production of adhesin by cariogenic bacteria [1]. This may hinder the ability of cariogenic bacteria to form dental plaque, furthering fluoride's cariostatic abilities.

### **III. Composition Of Topical Professional Fluorides**

#### **1. Concentration:**

- 2% Sodium Fluoride (NaF)
- 8% Stannous Fluoride(SnF<sub>2</sub>)
- Acidulated Phosphate Fluoride (APF) with 1.23% fluoride [6].

Fluoride ion concentration ranges from 225 parts per million (ppm) in over-the-counter oral rinses to 22,600 ppm in the fluoride varnishes.

#### **2. Generally Recommended for:**

- Patients at higher risk for caries.
- Orthodontic patients.
- Patients undergoing head and neck radiation.
- Patients with decreased salivary flow [6].

#### **3. Effect Of Fluoride on Enamel:**

##### ***Enhancement of Remineralization:***

Fluoride proved to make the tooth surfaces more resistant to dental caries by binding to hydroxyapatite crystal and forming the more stable and compact crystals called "*Fluorapatite*" [7].

##### ***Inhibition of demineralization:***

- Fluoride strongly adsorbs to the surface of enamel crystals
- Acts as a barrier against acid dissolution
- At low PH Fluoride travels in to subsurface of tooth and prevent the mineral crystal from dissolving [7].

##### ***Inhibition Of Bacterial Activity:***

- Ionized fluoride can not cross the bacterial cell wall.
- Cariogenic bacteria produce acid during metabolism of carbohydrates.
- Fluoride ion (F<sup>-</sup>) combines with hydrogen ion (H<sup>+</sup>) and form HF.
- HF penetrates the bacterial cell wall.
- Once inside, it dissociates again, acidify the cell and releases F<sup>-</sup>
- F<sup>-</sup> interferes with bacterial enzymatic activity ie. Enolase, ATPase [7].

#### **4. Fluoride Sources:**

##### ***Sodium Fluoride:***

- Available in Gel and Foam
- NaF transforms the surface hydroxyapatite to Calcium fluoride instead of fluorhydroxyapatite.

- Subsequent loss of phosphate ion.
- Calcium fluoride serves as a fluoride reservoir.
- Since its Neutral, used for patient with porcelain and glass ionomer restoration.
- Should be applied for 4 min form max efficacy [8]

***Stannous Fluoride:***

- This composition temporarily resulted in prevention of the phosphate loss of NaF [8]

***Acidulated phosphate fluoride (APF):***

- APF 1.23%, 12300 ppm F, pH 3.2
- Available as Solution, Gel or Thixotropic Gel, and as Foam
- molar phosphoric acid added to NaF
- Favor the equilibrium to form more fluorohydroxyapatite / fluoroapatite.
- Low pH facilitates the rate of reaction and favors HF formation
- HF can diffuse in to Enamel → Main Benefit Over Neutral NaF
- Major final product is still calcium fluoride [8]

**IV. Effectiveness of Professionally Applied Topical Fluoride:**

**1. Application Methods: [8, 9, 11]**

- Placed in a tray that is held in the mouth for several minutes (4 minutes maximum)**  
e.g. Gel/Foam
- Used as a rinse**  
e.g. NaF mouth rinse
- Applied with a cotton swab or brush**  
e.g. varnish (teeth need to be dried before varnish applied)

- All three types of fluoride systems result in appreciable cariostatic benefits [8]
- Prevention/arrest of root surface lesions has been demonstrated in both in situ and clinical studies using fluoride gels, varnishes, and mouth rinses [10]
- The optimum delivery system of fluoride for protection against root caries has yet to be determined [12]
- There is insufficient evidence to address whether or not there is a difference in the efficacy of NaF versus APF gels [10]

**V. Benefits and Patient Acceptance:**

**1. Foam [8,13,16]:**

- Requires smaller amount of application resulting in a lower fluoride dose
- Better tolerated than gels (reduced gagging)
- The weight of the clinical evidence of foam's effectiveness is not as strong as it is for fluoride gel/varnish

- There are clinical and laboratory data that demonstrates that foam and gels are similar in their fluoride release
- Clinical trials evaluating the effectiveness of foam in caries prevention is limited (only 2 trials as of 2006)

## **2. Gel [8,11]:**

- Better adherence to the teeth
- May not penetrate interproximal areas as well as solutions

## **3. Mouth rinse [9,14]:**

- Stronger concentration than that in mouth rinses available in a store or at a pharmacy
- Increased patient acceptance

## **4. Varnish [8,15]:**

- Small volume, less time
- Well received by patients (less discomfort)
- Less likely to be swallowed in comparison to other forms

## **VI. Is there any additional benefit to the use of professionally applied topical fluoride treatment for patients who routinely uses fluoride toothpaste?**

- Most studies have shown the effectiveness of fluoride use in dental caries reduction.
- The Cochrane Review [17] stated that additional forms of topical fluoride can reduce tooth decay compare to toothpaste alone. However, the difference is not that great.
- There are some limitations to these findings: even though this review was published in 2009, most of studies are from 70s and 80s. In addition, the studies don't represent the general population because the participants were children and adolescent (age-specific).
- The Journal of American Dental Association [16] found that patients whose caries risk is low may not receive additional benefit from professional topical fluoride application. Such low risk populations include any age groups that have no incipient or cavitated primary and secondary carious lesions during the last three years AND have no risk factors that may increase caries risk such as high titers of cariogenic bacteria, poor oral hygiene, genetic abnormality of teeth, drug or alcohol abuse, etc.
- However, additional professionally applied topical fluoride therapy in a dental setting is actually recommended to those in moderate and high risk populations who have increased caries risk factors. High risk groups include those with xerostomia, low socioeconomic status, or lack of fluoride exposure [16].
- Since many of the caries risk factors can change over time, a person who once has had low caries risk can always change to have moderate/high risks. It is

therefore important for a dentist to re-evaluate a patient periodically and give appropriate preventive therapy including topical fluoride [16].

**VII. Indications for use**

- Once the patient’s risk has been determined the intervals between fluoride treatments can be determined.
- No treatment schedule is provided by the ADA for the use of fluoride foam because its efficacy has not been positively demonstrated in the literature [16].
- Strong literature evidence exists for the treatment of patients from 0 – 18 years old but there is very little literature support for treating patients above 18 years of age.
- Ultimately, the guidelines are extremely flexible, leaving decisions regarding fluoride form (varnish, gel, foam) and treatment intervals up to the dentist’s hands.

*Table 1 – Professional topical fluoride treatment intervals*

	<6 years	6-18 years	18+ years
Low Risk	-Use professional judgment	-Use professional judgment	-Use professional judgment
Medium Risk	-Varnish -6 mo intervals	-varnish or gel -6 mo intervals	-varnish or gel -6 mo intervals
High Risk	-Varnish -3 or 6 mo intervals	-varnish or gel -3 or 6 mo intervals	-varnish or gel -3 or 6 mo intervals

**VIII. Is there any harm in receiving too much fluoride?**

Yes, excess fluoride can lead to:

- Dental Fluorosis
- Skeletal Fluorosis
- Systemic Fluorosis

**1. Dental Fluorosis (DF):**

Also referred to as Enamel Fluorosis or Molten Enamel is the hypomineralization of the enamel surface which develops during tooth formation as a result of excess fluoride consumption. [18]

***What does it look like?*** - Clinical appearance ranges from mild to severe forms.

Mild Dental Fluorosis presents with:

- Scattered, white flecks
- Opaque spotting
- Fine, lacelike lines

on the enamel surface of teeth.

Severe Dental Fluorosis presents with:

- Rough, irregular enamel surface (pitted, cracked)
- Brown stains [19][21]

***Who is at risk?***

Children under the age of 8 years old are at risk. Once the tooth has erupted they are no longer at risk therefore adults, adolescents and children above the age of 8 cannot develop dental fluorosis. [18]

## **2. Skeletal Fluorosis (SF):**

A progressive but non life threatening disease in which bones increase in density and become more brittle. [20]

Mild cases will include pain and stiff joints with limited range of movement. Severe cases will involve difficulty in moving, deformed bones which have a greater risk of bone fracturing. In the most severe case the spine can become completely rigid.

SF is extremely rare in the US. It has occurred in some people who had consumed 30 times the amount of fluoride typically found in fluoridated water. Reported cases however are found almost exclusively in developing countries such as India and China and are usually associated with malnutrition. [18]

## **3. Systemic Fluorosis**

Ingesting large amounts of sodium fluoride at one time can lead to

- Stomach aches
- Vomiting
- Diarrhea

Extremely large amounts of fluoride can cause death by affecting your heart. Excess fluoride binds with serum calcium resulting in hypocalcaemia. Severe cardiac effects such as tetany, decreased myocardial contractility, cardiovascular collapse and ventricular fibrillation that is observed at or near lethal doses are probably due to the electrolyte imbalance. [18]

Inadequate and poorly designed human studies along with conflicting animal studies have limited the usefulness of their findings and assessment of the potential of fluoride to induce undesired reproductive and IQ effects. The weight of evidence of other studies



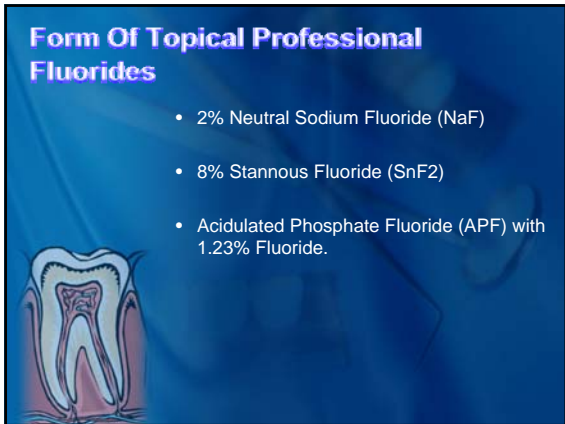
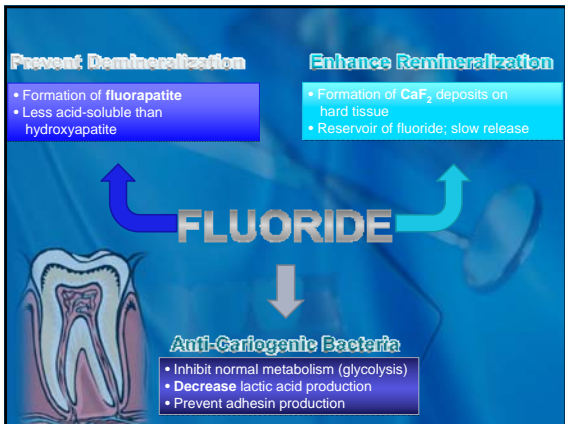
that have tried to associated fluoride water levels with cancer have also not been able to stand. The IARC (International Agency for Research on Cancer) has determined that the carcinogenicity of fluoride to humans is not classifiable. [18]

Like many natural substances, fluoride can be harmful in excessive amounts. Even table salt can be harmful if taken in large amounts. However, we are typically exposed to acceptable amounts of fluoride, even though it is available from a number of sources. [18]


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### Generally Recommended for


-  Patients at higher risk for caries.
-  Orthodontic patients.
-  Patients undergoing head and neck radiation.
-  Patients with decreased salivary flow.




### Sodium Fluoride (NaF):




- Available in Gel, Foam and Varnish
- NaF transforms the surface hydroxyapatite to mainly calcium fluoride instead of fluorapatite.
- Calcium fluoride serves as a fluoride reservoir.
- Subsequent loss of phosphate ion.
- Since it's neutral, best used for patient with porcelain and glass ionomer restoration.



### Stannous Fluoride:




- This composition temporarily resulted in prevention of the phosphate ion loss seen in NaF.




### Acidulated phosphate fluoride (APF):


- APF 1.23%, 12300 ppm F, pH 3.2
- Available as Solution, Gel or Thixotropic Gel, and as Foam
- Phosphoric acid added to NaF
- Form more fluorapatite.
- Major final product is still calcium fluoride.
- Low pH facilitates the rate of reaction and favors HF formation
- HF can diffuse in to Enamel → Main Benefit Over Neutral NaF




### Effectiveness Of Professionally Applied Topical Fluoride:



- Placed in a tray that is held in the mouth for several minutes (4 minutes maximum)  
e.g. Gel/Foam
- Used as a rinse  
e.g. NaF mouth rinse
- Applied with a cotton swab or brush  
e.g. varnish (teeth need to be dried before varnish applied)



### Benefits and Patient Acceptance:



FOAM	GEL	MOUTH RINSE	VARNISH
<ul style="list-style-type: none"> <li>• Requires smaller amount of application resulting in a lower fluoride dose</li> <li>• Better tolerated than gels (reduced gagging)</li> </ul>	<ul style="list-style-type: none"> <li>• Better adherence to the teeth</li> <li>• May not penetrate interproximal areas as well as solutions</li> </ul>	<ul style="list-style-type: none"> <li>• Stronger concentration than that in mouth rinses available in a store or at a pharmacy</li> <li>• Increased patient acceptance</li> </ul>	<ul style="list-style-type: none"> <li>• Small volume, less time</li> <li>• Well received by patients (less discomfort)</li> <li>• Less likely to be swallowed in comparison to other forms</li> </ul>

### Any additional benefit to the use of professionally applied topical fluoride treatment for patient who routinely uses fluoride toothpaste?





### No Or Little Benefit

Patients in low risk group  
no carious lesions during the last three years  
+  
no caries risk factors


### There Is Benefit

Patients in moderate/high risk group



XX. Professionally applied topical fluoride: evidence-based clinical recommendations. JADA. 2006 August;137(8):1151-9.




Moderate caries risk group	High caries risk group
One or two lesions during the last three years	Three or more lesions during the last three years
OR	OR
No lesion during the last three years	Lack of fluoride exposure
+	OR
at least 1 caries risk factor	Low socioeconomic status
	OR
	Xerostomia
	OR
	Multiple caries risk factors



XX. Professionally applied topical fluoride: evidence-based clinical recommendations. JADA. 2006 August;137(8):1151-9.

### Caries Risk Factors

- active orthodontic treatment
- high levels of cariogenic bacteria
- poor diet
- multiple restorations or restorations of poor quality
- alcohol or drug abuse
- And many others...


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### Professional Topical Fluoride Treatment Schedule

	<6 years	6-18 years	18+ years
Low Risk	-use best judgment	-use best judgment	-use best judgment
Medium Risk	-varnish -6 mo intervals	-varnish or gel -6 mo intervals	-varnish or gel -6 mo intervals
High Risk	-varnish -3 or 6 mo intervals	-varnish or gel -3 or 6 mo intervals	-varnish or gel -3 or 6 mo intervals

strong literature support

poor literature support



### Excess Fluoride Can lead to Fluorosis

		Signs & Symptoms	Who's at risk
Dental	Hypomineralization of tooth enamel	Scattered white flecks, opaque spotting, brown stains on enamel surface of teeth.	Up to the age of 8
Skeletal	Bones increase in density but becomes more brittle.	Pain, stiff joints, deformed bones and even rigid spine.	Long term condition (usually over 10 years)
Systemic	Toxic levels	Stomach aches, vomiting, diarrhea, heart failure.  Reproductive? IQ? Cancer?	Anyone who ingests large amounts of fluoride at once





### Is there any harm in receiving too much fluoride?

Like many natural substances, fluoride can be harmful in excessive amounts.

However, we are typically exposed to acceptable amounts of fluoride, even though it is available from a number of sources.

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