

Session 1B



Preventive Therapies for the Management of
Dental Caries:-
The science behind caries management

Protective Factors

Session 1B Protective Factors and Remineralization



Session 1B - Part 1 Protective Factors – Saliva

The Caries Balance

Pathological Factors

- Acid-producing bacteria
- Frequent eating/drinking of fermentable carbohydrates
- Sub-normal saliva flow and function

Protective Factors

- Saliva flow and components
- Fluoride, Calcium, Phosphate: remineralization
- *Antibacterials*:- chlorhexidine, Silver DF, HClO, new?

Caries

No Caries

Featherstone, Community Dent Oral Epidem, 1999

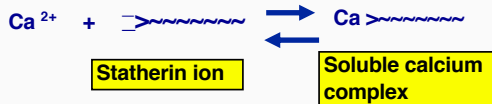
Protective factors

- ◆ Salivary components and flow
- ◆ Fluoride, calcium and phosphate: remineralization
- ◆ Antibacterials from extrinsic sources

Saliva Contains Numerous Important Components

- ◆ Calcium, phosphate and fluoride
- ◆ Proteins and lipids that form the pellicle that protects the tooth surface
- ◆ Proteins that keep calcium in solution - they maintain supersaturation
- ◆ Buffers against acid: bicarbonate, phosphate, peptides
- ◆ Antibacterial substances & immunoglobulins

Saliva Contains Proteins (e.g. Statherin) That Maintain Calcium and Phosphate in Supersaturated Solution



Clearance

- ❖ Saliva clears carbohydrates from the plaque
- ❖ Reduced saliva flow means less of all the components, less clearance, less protective effect
- ❖ Normal stimulated flow rate is about 1.0 ml/minute or more
- ❖ Stimulated flow rate of less than 0.5 ml/minute is a high risk factor for dental caries

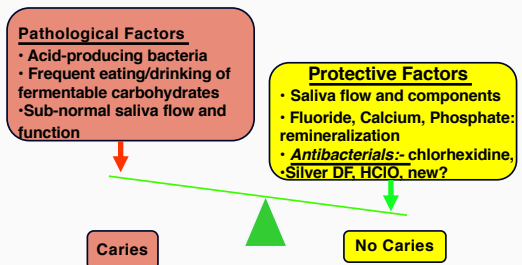
Saliva Summary - Caries Effects

- ❖ Salivary proteins contribute to the pellicle to protect the outer surface
- ❖ Salivary proteins maintain supersaturation of calcium phosphate
- ❖ Salivary calcium and phosphate inhibit demineralization and enhance remineralization
- ❖ Saliva carries fluoride around the mouth
- ❖ Salivary components buffer plaque acids
- ❖ Salivary proteins have antibacterial properties



**Session 1B – Part 2
Protective Factors – Fluoride
Inhibits Demineralization**

The Caries Balance

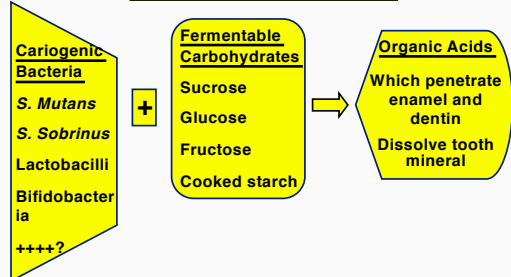


Featherstone, Community Dent Oral Epidem, 1999

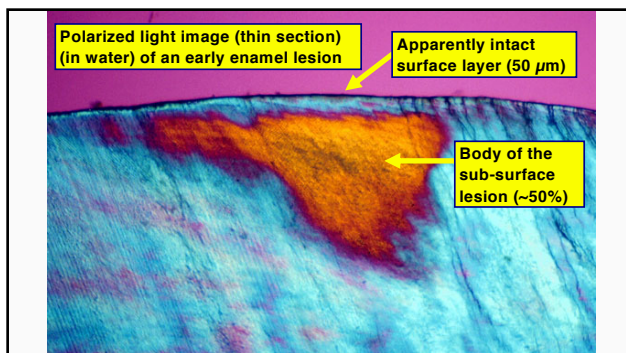
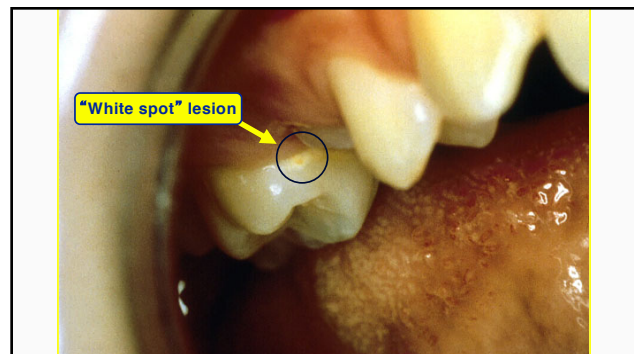
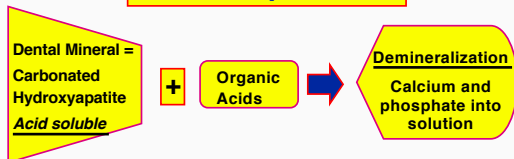
Protective factors

- ◆ Salivary components and flow
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Demineralization:- Step 1

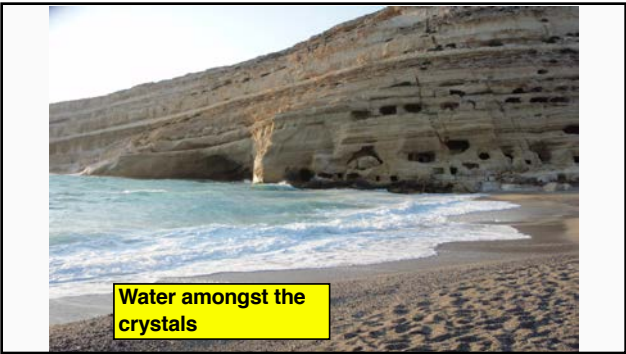
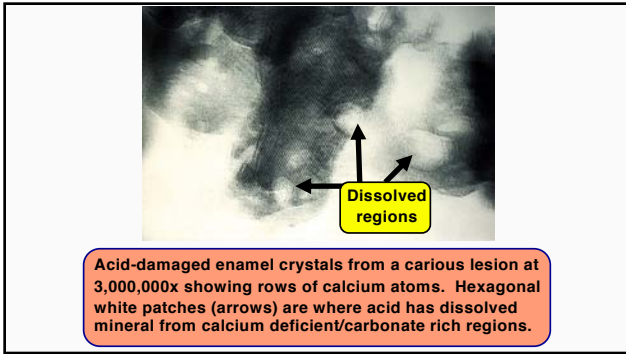
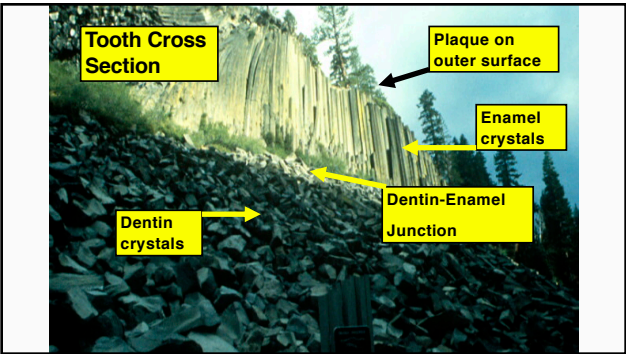
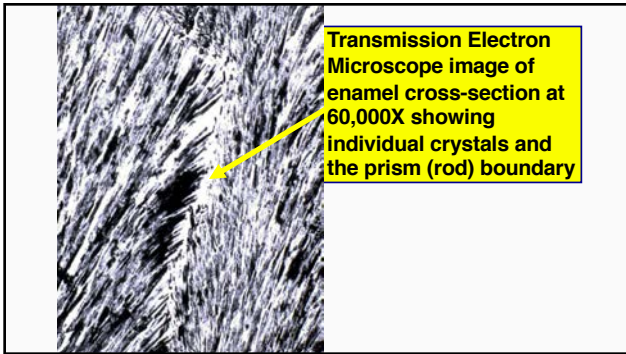
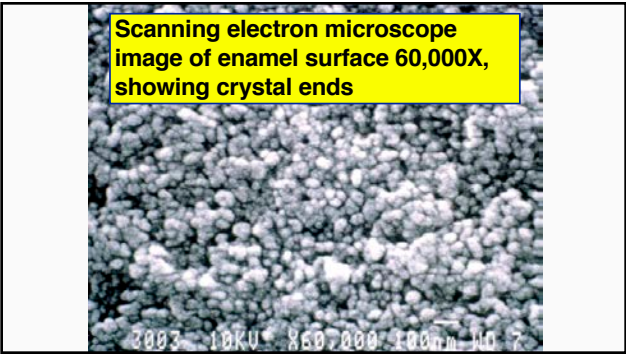
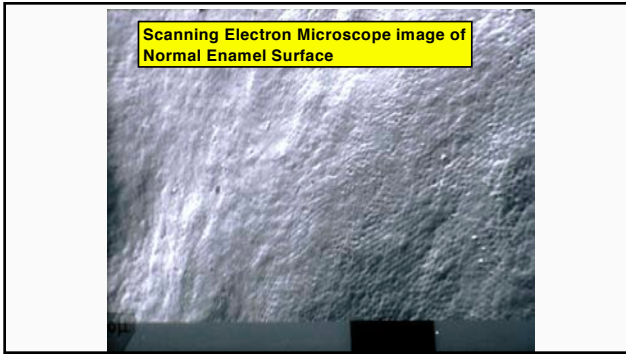


Demineralization:- Step 2



Electron Microscope





Demineralization:- Step 2

Dental Mineral =
Carbonated
Hydroxyapatite
Acid soluble

+

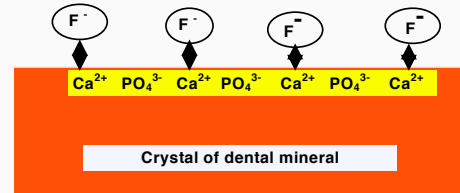
Organic
Acids



Demineralization
Calcium and
phosphate into
solution

If fluoride is present in the solution
between the crystals it inhibits
mineral loss

Schematic cartoon of
adsorption of fluoride ions
onto crystal surfaces



Fluoride adsorbs to the surface of the
crystals protecting against acid attack



Fluoride works primarily via
topical (surface) mechanisms
(Fluoride in water, foods, beverages, products)

◆ **Fluoride inhibits demineralization**



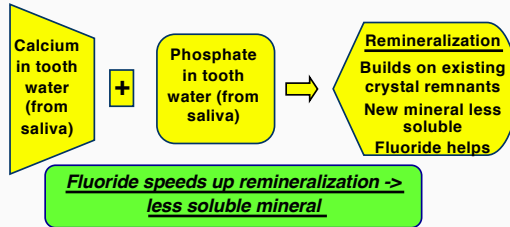
Session 1B – Part 3
Protective Factors - Fluoride
Enhances Remineralization



What can be done to
alter the surface of
the enamel or dentin
crystals?

Remineralization
creates a new
surface.

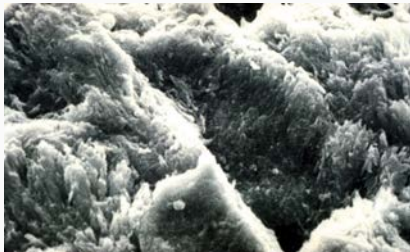
Remineralization/Tooth Repair



Featherstone, JADA, 2000

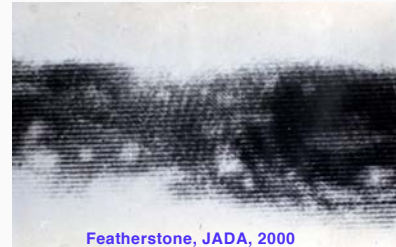
Subsurface Demineralization/Remineralization

- ❖ Acids diffuse into the subsurface of dental enamel or dentin partially dissolving the calcium phosphate crystals
- ❖ If this mineral loss is not halted or reversed a cavity results
- ❖ Reversal by remineralization produces low solubility mineral



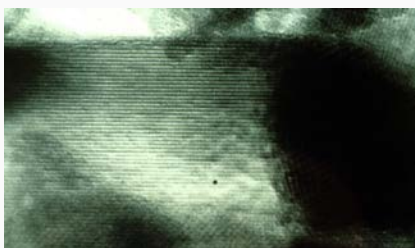
SEM in the body of a carious lesion (~ 30,000x) showing remaining crystal remnants awaiting remineralization

Featherstone, Australian Dental Journal, 2008



Featherstone, JADA, 2000

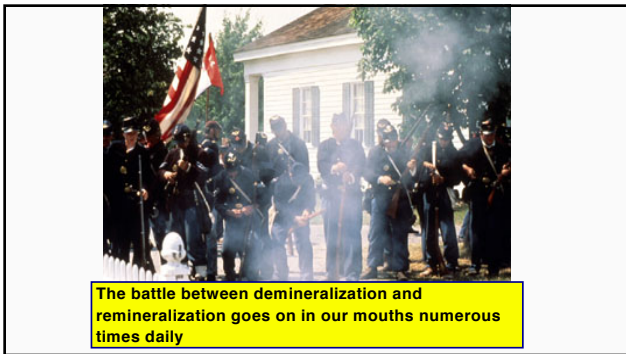
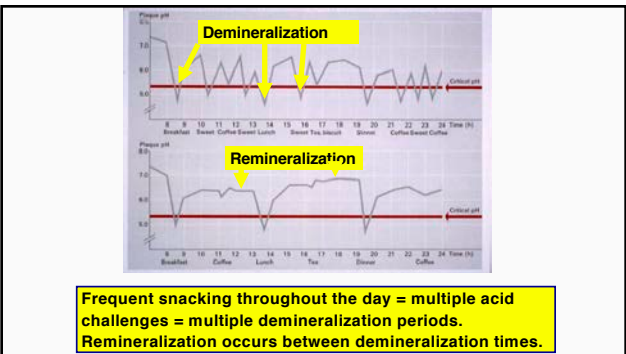
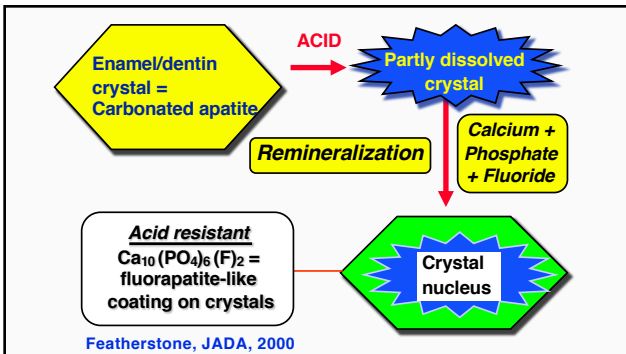
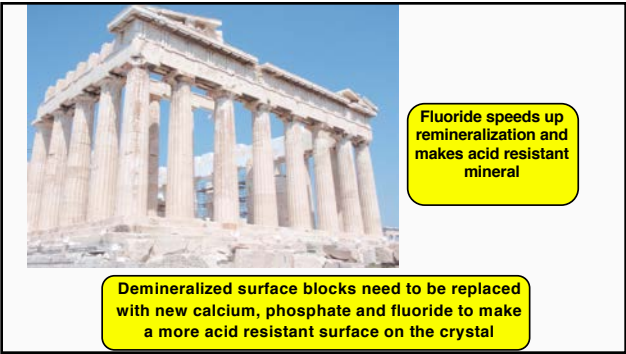
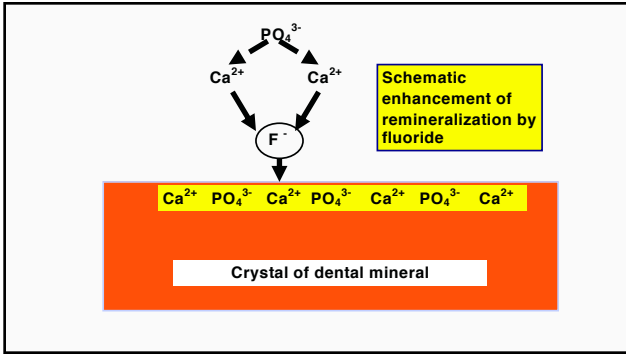
Partly demineralized enamel crystal (3,000,000x) dissected from inner enamel showing carbonate rich acid soluble regions (white patches).



Enamel crystal after remineralization with calcium, phosphate and fluoride, showing a well-formed, low solubility, fluorapatite-like veneer overlying the original defective crystal



Demineralized surface blocks need to be replaced with new calcium, phosphate and fluoride to make a more acid resistant surface on the crystal



Fluoride works primarily via topical (surface) mechanisms (Fluoride in water, foods, beverages, products)

- ❖ Fluoride inhibits demineralization
- ❖ Fluoride enhances remineralization



**Session 1B – Part 4
Protective Factors - Antibacterial
Effects of Fluoride**

$H^+ + F^- \rightleftharpoons HF$

$H^+ + F^- \rightleftharpoons HF$

Bacterial Cell

pH 7 $H^+ + F^- \rightleftharpoons HF$

pH 4.5 $H^+ + F^- \rightleftharpoons HF$

Fluoride can not enter bacteria in its ionic form, but as the bacteria produce acid HF is formed, which diffuses readily into the cells

Hamilton and Bowden, Fluoride in Dentistry, 1996

**Fluoride works primarily via
topical (surface) mechanisms**
(Fluoride in water, foods, beverages, products)

- ❖ Fluoride inhibits demineralization
- ❖ Fluoride enhances remineralization
- ❖ Fluoride can inhibit plaque bacteria

What can we do with this knowledge?



**Session 1B – Part 5
Fluoride Sources – Water and Over
the Counter Products**

Fluoride in saliva at concentrations of 0.04-0.1 ppm can markedly enhance remineralization

Featherstone et al., J Den Res, 1990

Fluoride in Drinking Water Effective Post-eruptively in Children and Adults

- ❖ Hardwick et al, 1982, showed caries reduction of ~27% over 4 years in 12 year olds when fluoride was added to their drinking water
- ❖ Stamm et al., 1990, showed reduction in root caries in older adults living in fluoridated drinking water area



What about the clinical relevance of remineralization?

Fluoride products enhance remineralization
Remineralization is the body's natural repair mechanism for dental caries



Numerous clinical trials showed ~30% reduction with fluoride toothpaste 1000-2800 ppm F.
Curnow, Pine, et al, 2002 reported 56% reduction with supervised brushing 2 x daily with a 1000 ppm F toothpaste compared with unsupervised



Brushing at least twice daily with a fluoride-containing toothpaste is one of the most effective ways to control dental decay.
High bacterial challenge overcomes the therapeutic effects of fluoride.



- Sodium Fluoride
- Stannous Fluoride plus multiple agents
- Stannous Fluoride plus multiple agents
- Sodium Fluoride + Baking Soda
- Sodium Fluoride + Whitening



Over the counter fluoride rinses (0.05% NaF) are effective in moderate caries risk patients: twice daily for one minute, plus a fluoride-containing dentifrice. O' Reilly and Featherstone, 1987



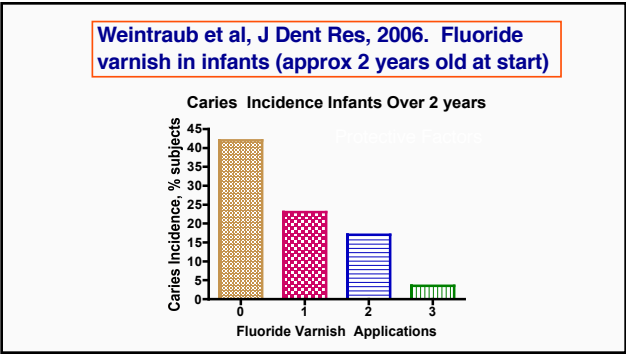
Session 1B – Part 6
Fluoride in the Dental Office and by Prescription

**Office-Applied Fluoride Products
Gel ($\geq 5,000$ ppm F)
and Fluoride Varnish**

- ❖ Do not require continuing patient compliance
- ❖ Forms slowly soluble calcium fluoride-like deposits in lesions and the plaque
- ❖ Gives slow release fluoride for several weeks
- ❖ Three times a year for high risk patients

**Evidence-based Clinical Recommendations:
Professionally Applied Topical Fluoride**
The Council on Scientific Affairs, American Dental Association May, 2006. Updated 2013

- ❖ Fluoride gel applied for 4 minutes or more is effective
- ❖ Fluoride varnish applied every 6 months is effective
- ❖ Two or more applications of fluoride varnish per year are effective in high caries risk individuals
- ❖ Office topical applications no added benefit for low risk individuals



Caries Research

Caries Res 2010;44:323-331
DOI: 10.1159/000317490

Received November 24, 2009
Accepted after revision April 28, 2010
Published online July 1, 2010

Preventive Effect of High-Fluoride Dentifrice (5,000 ppm) in Caries-Active Adolescents: A 2-Year Clinical Trial

A. Nordström D. Birkhed

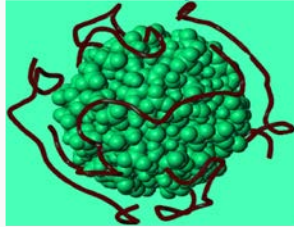
- ❖ 5000 ppm F vs 1450 ppm F (as NaF) toothpaste
- ❖ Caries incidence and caries progression
- ❖ Compliance assessed
- ❖ Prevented fraction 40%: 5,000 ppm versus 1450 ppm F
- ❖ Caries still progressed in many, even with high concentration fluoride



Calcium Phosphopeptide: CPP/ACP

Laboratory studies: Three decades
Clinical Studies: clinical evidence
Reynolds et al., numerous publications

Representation of a proposed CPP-ACP complex

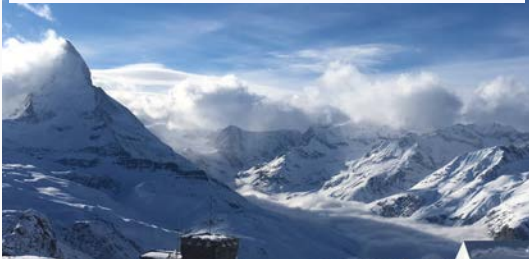


Cross et al. 2007 *Curr Pharm*



Use MI Paste Plus with Fluoride MI Paste = Tooth Mousse

**Fluoride alone is not enough for high risk patients:-
Biofilm modification is also necessary**



**Session 1B- Part 7
Protective Factors – Antibacterial
Agents for Caries Control**

The Caries Balance

Pathological Factors
 • Acid-producing bacteria
 • Frequent eating/drinking of fermentable carbohydrates
 • Sub-normal saliva flow and function

Protective Factors
 • Saliva flow and components
 • Fluoride, Calcium, Phosphate: remineralization
 • *Antibacterials*:- chlorhexidine, Silver DF, HClO, new?

Caries

No Caries

Featherstone, Community Dent Oral Epidem, 1999

Protective factors

- ◆ Salivary components and flow
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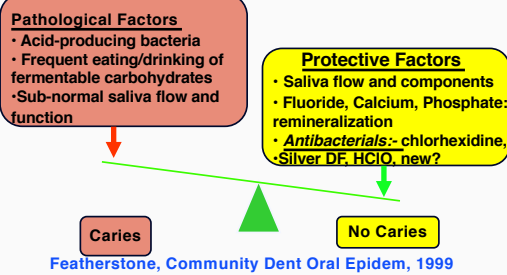
Biofilm Modification is necessary as part of our therapy for high bacterial challenge individuals. Caries is a transmissible bacterial infection. Biofilm dysbiosis must be replaced by symbiosis (Marsh, Adv Dent Res, 2018)



Caries is a Transmissible Bacterial Infection

- ❖ Multiple acid-producing species of bacteria are responsible
- ❖ Children are infected by mothers, care-givers, siblings, playmates, through saliva transfer
- ❖ Babies and infants are most susceptible from birth to about 4 years of age
- ❖ Children infected early have more cavities later in life
- ❖ Need to break the chain of infection and deal with the bacteria
- ❖ Need to change from dysbiosis to symbiosis in the biofilm

The Caries Balance



Original Paper

Caries Research

Caries Res 2012;46:118-129
DOI: 10.1159/000337241

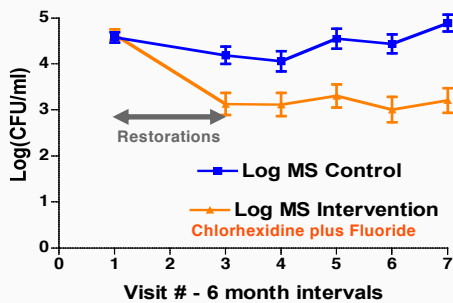
Received:
Accepted:
Published:

Caries Res, 2012

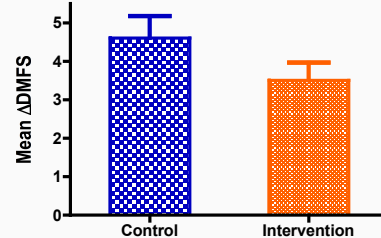
A Randomized Clinical Trial of Anticaries Therapies Targeted according to Risk Assessment (Caries Management by Risk Assessment)

J.D.B. Featherstone J.M. White C.I. Hoover M. Rapozo-Hilo J.A. Weintraub
R.S. Wilson L. Zhan S.A. Gansky
University of California, San Francisco, Calif., USA

Mean (SE) logMS



ΔDMFS (SE) 24% reduction (p=0.02)

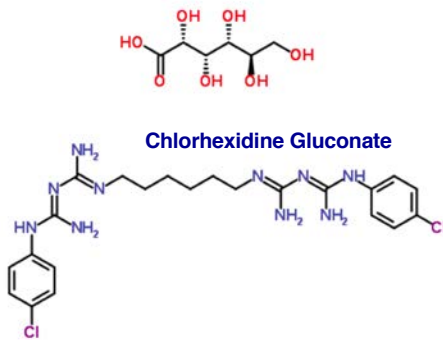


- ❖ Chlorhexidine was effective at reducing the bacterial challenge in high caries risk individuals even when compliance was problematic. 24% reduction in Δ DMFS
- ❖ Preferred regimen is once a day rinse for one week every month for a year
- ❖ Ideally monitor success by bacterial tests
- ❖ Ideally we need a better antibacterial therapy
- ❖ Must combine with remineraization/fluoride

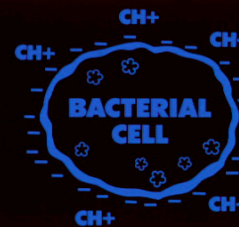


Chlorhexidine Gluconate 0.12%, 10 ml, daily for 1 week reduces MS markedly and LB somewhat after restorations completed. Repeat every month.

Use for ages 6 years through adult

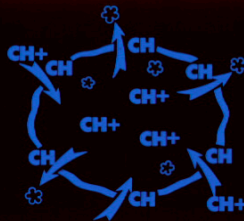


CHLORHEXIDINE MECHANISM OF ACTION



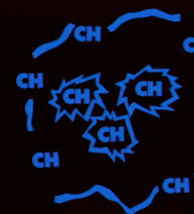
Opposite Charges Attract

CHLORHEXIDINE MECHANISM OF ACTION



Permeability Changes

CHLORHEXIDINE MECHANISM OF ACTION



Cell Death

Effective against mutans streptococci, but lactobacilli are resistant in the mouth

Silver Diamine Fluoride (SDF)



Can use SDF as an antibacterial and remineralizing agent to arrest decay in primary teeth and root caries.

Professor Crystal will discuss SDF in detail



Xylitol and caries control Does it work?

Xylitol Gum, Mints

Xylitol

- ◆ Noncariogenic sweetener
- ◆ Chewing enhances remineralization
- ◆ Replaces fermentable carbohydrates for frequent snackers



Zhan et al, J Dent Res, 2012 showed 7 fold difference between xylitol and placebo



Spiffies

Dental Wipes

Infant & Toddler Cleansing Formula



Grape Flavored

HANDY DISPENSER PACKAGE
48 Individually Wrapped Towelettes

What about toddlers/preschoolers?

- ❖ Chlorhexidine has negatives – no clinical proof in infants
- ❖ Chewing xylitol gum inappropriate & mints might be aspirated
- ❖ Xylitol wipes? - Spiffies: Zhan et al, 2012, J Dent Res, caries reduction over one year in infants
- ❖ Enlist the mothers and caregivers
- ❖ Silver diamine fluoride for high risk 0-5 years for deciduous teeth – staining issue (Crystal et al, 2017)
- ❖ Dr. Crystal will present in detail in session 3

Management of the biofilm is critical in high caries risk patients



Course Objectives – Session 1

- ❖ Understand the process of dental caries as a bacterially triggered disease and the many factors that influence the disbalance of the oral microbiome.
- ❖ Understand and know the pathological and protective factors related to caries initiation, progression and prevention clinically,
- ❖ Know the type and availability of fluoride products and delivery systems, antibacterial therapy, dietary modification and silver diamine fluoride for caries control.

**Time to get
ready for
skiing
tomorrow**

