Dental Caries
in the New Millennium:
Diagnosis and Treatment
Subjective
Objective
Assessment
Plan
Caries Risk Assessment
Caries versus Cavities

Caries is the disease process initiated predominately by mutans Streptococci.

Cavities are the result of the caries disease process.
Caries to Cavities

1. Healthy tooth
2. White spot lesion (caries process)
3. Caries process with cavitation
4. Restoration with caries process and cavitation
5. Continued demineralization and undermined enamel
6. Fractured tooth
High Risk Factors from History – Kids

- Systemic diseases
- Immune compromise
- Mouth breathing
- Gums bleed when brushing
- Sweetened medicines
- Family members with cavities
- Insufficient fluoride in non-fluoridated areas
- Deep unsealed teeth

- Bottles and sippy cups with milk and/or sugary liquids
- High intake of fermentable high density carbohydrates between meals
- Raisins, cereals, sugar treats between meals
- History of ECC
- History of fillings
- Irregular dental visits
High Risk Factors from History – Adults

- Systemic diseases
- Immune compromise
- Mouth breathing
- Gums bleed when brushing
- Orthodontic appliances
- White spot lesions or incipient lesions on x-rays
- Sporadic dental visits
- Failing restorations
- High caries rate in family members

- Disease
- Poor dexterity
- Inadequate fluoride sse
- Frequent intake of fermentable high density carbohydrates
- More than two cavities in the last year or active caries.
- Use of smokeless tobacco
- Xerostomia by itself or with exposed root surfaces
- Radiation therapy
Department of Cariology
University of Malmö

Cariogram

www.db.od.mah.se/car/cariogram/cariograminfo.html
Caries Risk Assessment

- **Level 1 – Inactive / No Disease**
  - (Caries -) (Cavities -)

- **Level 2 – Post-Manifest Disease**
  - (Caries -) (Cavities +)

- **Level 3 – Pre-Manifest Disease**
  - (Caries +) (Cavities -)

- **Level 4 – Manifest Disease**
  - (Caries +) (Cavities +)
Caries Treatment
Surgical Model

v

ANDs

Medical Model
Surgical Model

- Diagnose early
- Minimum intervention dentistry
- Treatment of cavities
- Treatment of secondary cavities
- Do what you have to do
Medical Model

- Diagnose early
- Prevention and therapeutics are active and linked
- Treatment of caries
- Can remineralize lesions up to $\frac{1}{3}$ into dentin if no cavitation
- Treatment of secondary caries
Medical Model

Adapted from *A Comprehensive Review of Pediatric Dentistry Manual*
San Diego, CA September 2002.
## Examination and Re-evaluation Schedule

<table>
<thead>
<tr>
<th>Level</th>
<th>Initial Visit</th>
<th>3 Months</th>
<th>6 Months</th>
<th>9 Months</th>
<th>12 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Exam, x-rays, etc.</td>
<td>Possible recare appt</td>
<td></td>
<td></td>
<td>Recare appt</td>
</tr>
<tr>
<td>ADA Code</td>
<td>D0150</td>
<td></td>
<td>D0120</td>
<td></td>
<td>D0150</td>
</tr>
<tr>
<td>Level 2</td>
<td>Exam, x-rays, etc. Treat cavities then B/TG/FV</td>
<td>Recare appt, x-rays</td>
<td></td>
<td></td>
<td>Recare appt</td>
</tr>
<tr>
<td>ADA Code</td>
<td>D0150</td>
<td></td>
<td>D0120</td>
<td></td>
<td>D0150</td>
</tr>
<tr>
<td>Level 3</td>
<td>Exam, x-rays, etc. B/TG/FV full mouth Recare appt, x-rays B/TG/FV</td>
<td>B/TG/FV</td>
<td>B/TG/FV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADA Code</td>
<td>D0150</td>
<td>D0170</td>
<td>D0120</td>
<td>D0170</td>
<td>D0150</td>
</tr>
<tr>
<td>Level 4</td>
<td>Exam, x-rays, etc. Treat cavities then B/TG/FV Recare appt, x-rays B/TG/FV</td>
<td>B/TG/FV</td>
<td>B/TG/FV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADA Code</td>
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<td>D0170</td>
<td>D0120</td>
<td>D0170</td>
<td>D0150</td>
</tr>
</tbody>
</table>

B = Betadine  
TG = Xylitol Tooth Gel  
FV = Fluoride Varnish
Medical Model

Adjunctive Tests
Oral pH Testing
Caries Risk Tests – Bacterial Counts
Dentocult® SM

- Low sensitivity – does not identify true positives well
- Good specificity – identifies low ms counts
- Helpful in initial risk assessment and monitoring progress at reducing ms counts
Dentocult® LB

- Not as useful as Dentocult® SM
- May aid in understanding greater acid production as *Lactobacilli* can survive and produce acids
Lactobacilli
[CFU/ml saliva]

< 10^5

≥ 10^5
Caries Risk Tests
ATP Bioluminescence
ATP Bioluminescence

- Initially developed as a test to assure clean (bacteria-free) surfaces in industry
- ATP combines with reagent to produce light (bioluminescence)
ATP Bioluminescence

- All living organisms contain varying amounts of ATP
- Acid-producing bacteria contain 100X more ATP than bacteria that do not produce acids
- Reported as RLUs (relative light units)
Caries Risk Tests
Real-time PCR
Real-time PCR

- PCR assay specific for *Streptococcus mutans*
- Visible marker positive if >500,000 CFU
Medical Model

Treatment Procedures and Protocols
Xylitol
Xylitol

- Gum (1g) – chew 2-3 pieces for 5 minutes 5 times a day
- Mints (1g) – dissolve 2-3 pieces 5 times a day
- 12-16 grams total per day
- Infant tooth gel – apply to teeth 2-3 times a day
Caries prevention by xylitol compared to a control group

% Reduction in Caries for Xylitol vs. Control
“Xylitol is only one part of a multiple intervention approach for the prevention of dental caries along with fluoride, chlorhexidine, dental sealants, mechanical plaque removal, and regular professional care.”

John Peldyak DMD
Xylitol Sweeten Your Smile
Advanced Developments, Inc.
Mt. Pleasant, MI
# Properties of Xylitol

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Formula</strong></td>
<td>( \text{C}<em>5\text{H}</em>{12}\text{O}_5 )</td>
</tr>
<tr>
<td><strong>Relative sweetness</strong></td>
<td>Equal to sucrose</td>
</tr>
<tr>
<td><strong>Glycemic index</strong></td>
<td>7</td>
</tr>
<tr>
<td><strong>pH in water</strong></td>
<td>5%: 5.6, 10%: 5.5, 40%: 5.4</td>
</tr>
</tbody>
</table>
Xylitol is:

- **Non-cariogenic**
  
  Does not contribute to the disease process

- **Cariostatic**
  
  The disease process does not occur in the presence of xylitol

- **Anti-cariogenic**
  
  The disease process may be reversed by appropriate exposure to xylitol
Turku Sugar Study

- **Summary**
  Two-year clinical trial at Turku University (Finland) to determine impact of xylitol as a complete substitute for other sugars

- **Method:**
  Randomly assign participants to three groups
  - One to eat foods sweetened with sucrose
  - One to eat foods sweetened with fructose
  - One to eat foods sweetened with xylitol

Scheinin A, Mäkinen KK, Ylitalo K. Turku sugar studies: V. *Acta Odontol Scand* 1975; 33 (suppl 70)
Belize Chewing Gum Study

- **Summary**
  - 24-month double-blind study of 510 6-year-old children to determine the effect of xylitol on the rehardening of dentin lesions in the primary dentition

- **Method**
  - Randomly assigned subjects to 7 groups and provide xylitol, sorbitol, xylitol-sorbitol mixture and a control group.
  - Regular supervision by school teachers for 200 days
  - Instructions for use on non-school days
  - Evaluate rehardening process of caries lesions

Before and After Photos

From the office of
Russ Misner, DDS and Larry Bybee, DDS
KiDDS Dental
716 Yellowstone
Pocatello, Idaho 83210
208-478-5437
infor@kiddsdental.com
100% Xylitol Gum Only

Before

1 Week
100% Xylitol Gum
and 0.12% Chlorhexidine

Before

3 Months
Xylitol Reduces Bacterial Regrowth After Oral Disinfection

Fluoride

DuraShield
5% Sodium Fluoride Varnish

Sultan Super Products

Fluoride
Fluoride

- Systemic
- Toothpaste
- Rinse
- Fluoride varnish
- 1.1% neutral sodium fluoride gel
Fluoride Toothpaste for Children

- Under age 2, water only
- Small, pea-sized amount beginning at age 2
- Supervised use under age 8 years
Fluoride Varnish

- 2500 ppm fluoride
- Copal varnish
- Sets in contact with moisture
- Will initially discolor teeth (~24 hours)
Fluoride Varnish Instructions

- No eating for the next hour
- Eat only soft foods at the next meal
- Do not eat sticky foods for 24 hours
- Do not brush teeth for 24 hours
Fluoride Varnishes

- Colgate Duraphat
- Duraflor
- VarnishAmerica
- DuraShield
Oral Antimicrobials

- Povidone-iodine (Betadine) 10% (B)
- Chlorhexidine 0.12 % (CHX)
- Carbamide peroxide 10-20 % (CP)
Long-term use of oral antimicrobials should be avoided, as it may be possible that after exposure the oral flora may develop resistance to these just as other micro-organisms have done with antibiotics.
Povidone-iodine Protocol for L2, L3 and L4

- All age groups
- Treat cavity preparation at the time of the procedure using povidone-iodine for toilet of cavity
- Treat the quadrant in which the procedure was performed with povidone-iodine
- At completion of all restorative procedures treat the entire mouth with povidone-iodine, xylitol tooth gel and fluoride varnish
- If feasible have fluoride varnish applied an 2 additional times in a 10 day period

Note: This is an off-label use for povidone-iodine.

Povidone-iodine Protocol (Continued) for L3 and L4

- Apply povidone-iodine, xylitol tooth gel and fluoride varnish every 3 months for a two year period or until you feel confident that the patient is following through with the xylitol program and you have a negative CRT.

Note: This is an off-label use for povidone-iodine.
Chlorhexidine Rinse Protocol for L3 and L4:

- Age 6 and older
- Rinse with ½ ounce once daily at bedtime for 14 days
- Repeat rinse cycle in 2 months
- Must be done 30 minutes after brushing, if patient is using a toothpaste containing sodium lauryl sulfate
- Institute a periodic fluoride varnish program
- Maintain a xylitol protocol
- Follow up with a CRT in 12 weeks
Carbamide Peroxide Protocol for L3 and L4

- Age 14 and older
- Apply via custom trays
- For disinfection, need only be applied once as per usual whitening routine
- Repeat in two months
- If performing a whitening procedure, oral disinfection is also occurring
- Institute a 1.1% neutral sodium fluoride program.
- Maintain a xylitol protocol
- Follow up with a CRT 12 weeks
PROSPEC™ MI Paste
PROSPEC™ MI Paste

- Contains RECALDENT™ (CPP-ACP)
- Casein phosphopeptide (CPP)
- Amorphous calcium phosphate (ACP)
- Promotes remineralization
- Under acidic conditions, CPP-ACP releases calcium and phosphate ions into tooth enamel
- Products containing CPP-ACP should not be consumed by people with milk protein allergies
Probiotics
Probiotics

- "Live microorganisms, which when administered in adequate amounts, confer a health benefit on the host" (Guarner et al 2005)
- Theory dates to early 1900’s Nobel Laureate Ilya Metchnikof
Recent Dental Research in Probiotics

<table>
<thead>
<tr>
<th>Test strain</th>
<th>Reference</th>
<th>Type of experiment</th>
<th>Feature tested</th>
<th>Result</th>
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</thead>
<tbody>
<tr>
<td>S. salivarius</td>
<td>Burton et al (2006a)</td>
<td><em>In vivo</em></td>
<td>Reduction of VSC</td>
<td>Reduced VSC levels</td>
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<tr>
<td>L. acidophilus</td>
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<td><em>In vivo</em></td>
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<tr>
<td>L. reuteri</td>
<td>Çaglar et al (2006)</td>
<td><em>In vivo</em></td>
<td>Inhibition of <em>S. mutans</em></td>
<td>Reduced <em>S. mutans</em> levels</td>
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<tr>
<td>Bifidobacterium DN-173 010</td>
<td>Çaglar et al (2005a)</td>
<td><em>In vivo</em></td>
<td>Inhibition of <em>S. mutans</em></td>
<td>Reduces levels of caries pathogens</td>
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<tr>
<td>L. rhamnosus GG Propionibacterium freudenreichii ssp. shermanii JS</td>
<td>Hatakka et al (2007)</td>
<td><em>In vivo</em></td>
<td>Inhibition of <em>C. albicans</em></td>
<td>Reduce high yeast counts</td>
</tr>
<tr>
<td>L. rhamnosus</td>
<td>Haukioja et al (2006a)</td>
<td><em>In vitro</em></td>
<td>Adherence</td>
<td>Better adherence than bifidobacteria</td>
</tr>
<tr>
<td>L. paracasei</td>
<td></td>
<td></td>
<td>Survival in saliva</td>
<td></td>
</tr>
<tr>
<td>L. johnsonii</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. rhamnosus GG L. casei</td>
<td>Haukioja et al (2006b)</td>
<td><em>In vitro</em></td>
<td>Inhibition of <em>S. mutans</em></td>
<td>Inhibit <em>S. mutans</em> adhesion to salivary pellicle</td>
</tr>
<tr>
<td>L. acidophilus</td>
<td></td>
<td></td>
<td>Adhesion</td>
<td>Different pattern of adhesion according to the test strain</td>
</tr>
</tbody>
</table>

VSC, volatile sulfur compounds.

(Meurman 2007)
Effect of Long-Term Consumption of a Probiotic Bacterium, *Lactobacillus rhamnosus* GG, in Milk on Dental Caries and Caries Risk in Children

L. Näse\(^a\) K. Hatakka\(^b\) E. Savilahti\(^c\) M. Saxelin\(^b\) A. Pönkä\(^c\) T. Puussa\(^f\) R. Korpela\(^b\) J.H. Meurman\(^a,d\)

2001, Nase et al, 594 children; randomized; DB; PCT; 7 month

Significant decrease in *Strept mutans* counts, on the order of one log value decrease in the experimental group and no change in the control.

Statistically significant reductions in caries in 3-4 year olds.

Study was too short to obtain conclusive data regarding caries reduction.
Replacement Therapy
Replacement Therapy

“a naturally occurring or laboratory derived effector strain is used to intentionally colonize the niche in susceptible host tissues that is normally colonized by the pathogen…” (Hillman 2002)
1984 JH1140 Strain Created

- Natural S.M. strain present in 2% of population
- Produced bacteriocin, mu-1140
- Bacteriocin killed virtually all other S.M.
- Modified strain to produce 3x more mu-1140
- Strain termed JH1140.

(Hillman 1984)
1985 Human Colonization

- Three year recall – all three volunteers still colonized.
- 2002 – two of three volunteers still colonized (Hillman 2002)
Modification of JH1140

- JH1140 still produced lactic acid
- 2000 – removed lactate dehydrogenase gene; inserted alcohol dehydrongenase gene
- No detectable lactic acid; ethanol primary product
- 50% decrease in caries in rat model
FDA Trials

- Cleared for Phase 1 Safety Trials
- FDA required modifications to prevent community spread (Hillman et al, 2007)
- Studies will be in edentulous patients
- Slated to begin “soon”

(onibiopharma.com)
Palmetto Health Dental Center
10 Richland Medical Park
Columbia, South Carolina 29203
803 - 434 - 6567

Patient Name: __________________________________________________________________

Rx to Prevent Tooth Decay Infections

☐ Standard fluoride toothpaste
   Brush for 2 minutes after each meal

☐ Floss or Proxabrush®
   Clean between teeth daily with dental floss, Proxabrush® or other aids

☐ Xylitol mints
   Enjoy 2-3 mints at least 5 times a day

☐ Prescription fluoride gel
   Brush for 2 minutes immediately before bedtime (spit out, but do NOT rinse afterward)

☐ MI Paste
   Place paste in tray, insert and wear for 5 minutes immediately before bedtime (spit out, but do NOT rinse afterward)

☐ Chlorhexidine 0.12% rinse
   Rinse for 30 seconds and spit twice a day for 2 weeks

Oral health takes a 24-hour day commitment from you. The recommendations provided will help to treat and prevent tooth decay infections, if you follow them regularly. Adjust the recommendations to fit your daily lifestyle, but don’t neglect them. If you miss one of the items on the list, just continue with the next one at the appropriate time.

Doctor: _______________________________ Date: ________________
Patient Name: __________________________________________________________________

RX to Prevent Tooth Decay Infections

☐ Standard fluoride toothpaste
   Brush for 2 minutes before each meal

☐ After meal rinse
   Rinse with water or water containing ½ teaspoon of dissolved baking soda

☐ Floss or Proxabrush®
   Clean between teeth daily with dental floss, Proxabrush® or other aids

☐ Xylitol mints
   Enjoy 2-3 mints at least 5 times a day

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Doctor: ____________________________________________ Date: ______________
StROOB

(Strategic Reset of Oral Biofilms)

Professors Brian B. Novy & Brian P. Black

Loma Linda University
School of Dentistry
Do not wait until the restorative procedures are completed to begin StROOBing and using xylitol.
StROOB In-office Protocol

Step #1
Polish or Prophy Jet

Step #2
Immediate 2 minute 10% povidone iodine rinse

Step #3
Immediate liberal application of MI Paste

Step #4
Keep pH above 7
StROOB At-home Protocol

0.12% chlorhexidine (CHX) rinse b.i.d.
NOT within 1 hour of using F toothpaste
Immediate application of MI Paste following CHX rinse

Keep pH above 7
Sodium bicarbonate rinses or lozenges
Xylitol 12-15 grams per day
Repeat for 7 days
*Strept mutans* does NOT proliferate when oral pH is above 6.6
Intensive Infant and Toddler Caries Prevention Program
“Cavitation eradication and ms control in mothers while pregnant, and from the time the baby is 6-30 months old, is crucial. This is the tooth eruption period and the child is most receptive to ms transmission from the mother at this time. Children are also at risk to transmission, but to a lesser degree, between 6-12 years of age.”

Arnold D. Steinberg, DDS, MS
Steven C. Steinberg DDS
University of Illinois at Chicago School of Dentistry
MS transmitted from mother or other primary caregiver to infant by...

- fingers
- sharing eating utensils
- cleaning pacifier with mother’s saliva
When to Start Caries Prevention

- Prevention of dental caries should begin six weeks before the end of term or just after the child is born.
- Alternatively, prevention can begin or should continue when the child is 6 months old.
- Care must be given to include the primary caregiver and close relatives.
Children Have Fewer Cavities When Mothers Use Xylitol

Knee-to-Knee Examination
Xylitol Infant and Toddler Tooth Gel

- Used after 6 months of age until child can chew gum responsibly
- Allows xylitol coverage during the eruption phase of the primary teeth
- Early intervention can significantly reduce the risk of the caries disease process and limit the number of cavities even further
Establish a Dental Home – Physician Referral

- Refer high risk children by 6 months
- Refer all children by the age of one
Diagnosis and Management of Dental Caries Throughout Life

National Institutes of Health
Consensus Development Conference Statement
March 26-28, 2001
Journal of Dental Education

Volume 65
Issue 10
2001
Caries Diagnosis, Risk Assessment, and Management
University of Michigan
www.db.od.mah.se/car/carhome.html

University of Malmö
Faculty of Odontology
Department of Cariology

Basic Cariology

www.db.od.mah.se/car/data/basic.htm
www.uic.edu/classes/peri/peri343/

Cariology Class
University of Illinois at Chicago
www.ahrq.gov/clinic/epcsums/dentsumm.htm

Agency for Healthcare Research and Quality (AHRQ)