**Dental Caries**

Advances in Detection & Disease Detection and Management

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**Learning Objectives**

- Recognize trends in caries epidemiology
- Identify indicators for increased risk of dental caries
- Compare various caries detection techniques
- Differentiate various agents used to arrest or reverse the demineralization process
- Implement a medical approach for the management of dental hard tissues

**A Silent Epidemic**

- Affects 97% of the population in their lifetime
  - Berg, J Eshet Restor Dent, 2007
- Most common chronic childhood disease
  - Mouradian et al, JAMA, 2000
- By age 17, ~ 80% of young people have had decay
  - NIH Consensus Statement 2001
- 70% of caries occur in 30% of children
Image courtesy of Dr. Frank Caughman

$\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$

$\text{Ca}_5(\text{PO}_4, \text{CO}_3)_3(\text{OH})$

Enamel

Plaque

Saliva

plaques

tooth

causes

diet
Pathological Factors
- Cariogenic bacteria
- Fermentable carbohydrates

Protective Factors
- Saliva components & flow
- Fluoride, Calcium, Phosphate
- Antibacterial agents

The Caries Balance

NO CARIES
REMIN

CARIRES
DEMIN

Featherstone 1999

Risk Based Approach
- More likely to develop dental caries
- Treat higher risk patients more aggressively

Caries Management by Risk Assessment
CAMBRA
- Assess risk factors to identify cause
- Manipulate risk factor to correct the balance

CAMBRA Clinical Study

- Confirmed the “Caries Balance” concept
- Fluoride alone cannot overcome high bacterial challenge
- Restorative tx does not reduce bacterial count in rest of oral cavity
- One or more frank lesions indicates high bacterial challenge and high risk for future decay
- Reducing caries risk by chemical therapy significantly reduced level of new caries

CAMBRA logistics—when and where is it done?

The dental hygiene department is the education and prevention center of every practice, where patients are seen routinely and frequently. CAMBRA naturally falls into place here.

The key thing to remember as we address the concern heard loud and clear from hygienists far and wide as they echo, “But I only have an hour!!” is that it’s not our hour. The hour belongs to our patients.

Assessment Tools

- AAPD CAT
  www.aapd.org
- CRA
  www.cdafoundation.org
  www.first5oralhealth.org
Pathological Factors
- Cariogenic bacteria
- Fermentable carbohydrates
- Salivary dysfunction

Protective Factors
- Saliva components & flow
- Fluoride, Calcium, Phosphate
- Antimicrobial agents

Featherstone, Young, Wolff 2007
Caries Risk Classification
JADA Aug 2006

LOW RISK
- No new or cavitated lesions during past 3 years
- No pathological factors that increase risk

MOD RISK
- 1-2 incipient or cavitated primary lesion
- Secondary lesions during past 3 years
- No primary or secondary lesion, but at least 1 pathological factor

HIGH RISK
- 3 or more primary or secondary lesion past 3 years
- Presence of multiple pathological factors

Detection Techniques
- Visual
- Tactile (Explorer)
- Radiographic
- Fiber optic transillumination
- Laser fluorescence
- Red-infrared reflectance

Lesion Progression
Dentist estimate:
- 6 mos- 1 year primary enamel
- 1 – 2 years permanent enamel

Studies demonstrate:
- 4 yrs for children aged 10-11
- 7 yrs for young adults aged 17 – 22
- 6 yrs for adults age 41-51
Detection Techniques...
Sensitivity, Specificity & Reliability

- **Sensitivity (SE)**
  - ability to identify the presence of a specific condition

- **Specificity (SP)**
  - accuracy in the identification of the condition

- **Reliability (R)**
  - The dependability or consistency of a measurement method

**Detection Techniques**
- Visual
- Tactile (Explorer)
- Radiographic

International Caries Detection and Assessment System (ICDAS)
Detection Techniques

- Visual
- Tactile (Explorer)
- Radiographic

Explorer:
- Insert with moderate – firm pressure
- “Catches” or resists removal

Accompanied by:
- Softness at base of area
- Opacity adjacent to pit or fissure
- Softened enamel adjacent to pit or fissure
- Catch not enough to diagnose

Explorer Concerns

- 62% sensitivity / low reliability
- False negatives
- Transference of infective S mutans to other sites?
- Disrupts intact surface layer, eliminating potential for reversal


Lussi, Caries Res 1991

Loesche et al, Arch Oral Biol 1973
Hujoel et al, Caries Res 1995
**Explorer Usage**

- Remove dental plaque
  - Gentle scraping action of shaft or tip
- Assess surface roughness
  - Active vs Arrested

**Detection Techniques**

- Visual
- Tactile (Explorer)
- Radiographic

**Radiograph Limitations**

- 40-60% demineralization required to produce image
- Underestimates size or depth
- Insufficient to determine activity level
- Low sensitivity
  - 39% occlusal
  - 50% interproximal

Bader et al 2001
Digital Radiography

- Comparable diagnostic accuracy
- May offer small gains in sensitivity
  - Contrast adjustment
  - Digital subtraction
  - Caries detection software

Detection Techniques

- Visual
- Radiographic

75% SE
90% SP

Ketly, Br Dent J 1993
Dental Caries

Adjunctive Detection Technologies

- Digital fiber optic transillumination
- Quantitative light fluorescence
- Infrared fluorescence
- Red-infrared reflectance
- Detects
  - Occlusal
  - Interproximal
  - Smooth surface
  - Recurrent
- Disposable tips
  - Occlusal & IP
Sensitivity

- Detects & monitors progression
- Occlusal & smooth surfaces
  - 61% occlusal SE / 59% SP
  - 76% smooth surface SE / 85% SP
- NO interproximal detection
- Good research instrument
**Infrared Fluorescence**

- Detects occlusal only
  - 80% mean sensitivity*
  - 86% mean specificity
- Dry field only
  - 2 mm depth
- Quantified results
  - Range = 0 – 99
  - >20 = dentinal caries

* Bader 2001

**Red Infrared Reflectance**

- Occlusal & interproximal detection
  - one tip
- Wet field
  - 3mm depth
- Visual & audible signals
  - Green light = health
  - Red light = demineralization
  - Intensity of beeping = extent of demineralization

**Caries Detection Sensitivity**

- Interproximal
  - 80%
  - 50%***
- Occlusal
  - 92%
  - 39%***

* 88% sensitivity based on a radiographic gold standard.
** 92% sensitivity based on a histological gold standard.
*** 39% and 50% represents an average of meta-analysis.

Source: J. Bader, "Systematic Reviews of Selected Dental Caries Diagnosis and Management Methods"
<table>
<thead>
<tr>
<th>Detection Method</th>
<th>Sensitivity %</th>
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<tbody>
<tr>
<td>IP 80</td>
<td>80</td>
</tr>
<tr>
<td>O 92</td>
<td></td>
</tr>
<tr>
<td>IP 80</td>
<td>69</td>
</tr>
<tr>
<td>O 80</td>
<td>75</td>
</tr>
</tbody>
</table>

**Need to stretch yet?**

**Dental Caries**

**Risk Factor Management**
Pathological Factors
- Cariogenic bacteria
  - Mutans streptococci
    - Strep mutans
    - Strep sobrinus
    - Lactobacilli species

Protective Factors
- Saliva components & flow
- Fluoride, Calcium, Phosphate
- Antibacterial agents

Pathological Factors
- Cariogenic bacteria
  - Fermentable carbohydrates
  - Salivary dysfunction

NO CARIES REMIN
CARIES DEMIN

Bacterial Culture Tests
- Establish baseline levels of MS & LB
- High risk patient
- Mothers
- New patients
- Monitor change
- High count $\geq 10^5$ CFU/ml*

*Krasse 1988
*Andersson et al 1993
Protective Factors

**Antibacterials**

**High Risk Patients**

**0.12% chlorhexidine**
- Reduces MS
- 10 ml
- 1 min
- Bedtime
- 1 week/month

Follow with 3 weeks of NaF rinse

**Protective Factors**

**Antibacterials**

**High Risk Patients**

**10% povidone-iodine**
- Reduces MS & LB in young children
- Professional application only
  - Swish
    - 10 ml / 1 min
  - Swab
    - 1-2 ml / 2 min

**Protective Factors**

**Antibacterials**

**High Risk Patients**

**Xylitol**
- Decreases levels of S mutans
- 1 gram/stick
  - Adults
    - 6-10 grams/day
  - Older children
    - 4-5 grams/day
Pathological Factors

Demineralization Potential
- Frequency of exposure
- Retentive nature
- Point of consumption

Soft Drink Consumption

Overall
- 56 gals/yr

Teen boys
- 81 gals/yr

Teen girls
- 61 gals/yr

Enamel dissolution

5.5
6.3

pH of saliva
1 tsp = 4 gm

19

Erickson et al 2001

Sip All Day, Get Decay®

www.mndental.org

• Flushes carbohydrates
• Buffers to neutralize acids
• Provides proteins & lipids
  • Protective pellicle
  • Supersaturation of Ca & PO
  • Antibacterial
• Carries fluoride
Pathological Factors

Salivary Dysfunction

Salivary Flow Rate

- ≥ 1 ml/min \(\text{NORMAL}\)
- 0.7 ml/min \(\text{LOW}\)
- < 0.5 ml/min \(\text{DRY}\)

Protective Factors

Saliva

- Buffering products
- Artificial saliva
- Xerostomia products
Caries lesion management

Protective Factors
F, Ca, PO

Mechanisms of Action
- Inhibits bacterial metabolism
- Inhibits demineralization
- Enhances remineralization

Fluoride

- Inhibits demineralization
Sources of Fluoride

- Systemic fluoride
  - 1000 – 2000 ppm in outer enamel
  - 20-100 ppm in subsurface

- Topical fluoride
  - 30,000 ppm

- Optimal salivary concentration
  - 0.1 ppm* for high risk
  - 0.02 – 0.04 ppm for low risk

Fluoride Dentrifices

- Sodium Fluoride 0.24% NaF
- Stannous Fluoride 0.4% SnF₂
- Sodium Monofluorophosphate 0.76% Na₂PO₃F

- 1000 – 1300 ppm
- ~35% reduction in caries
  - Range 15 – 50%
Rx Dentifrice

**High Risk Patients**

- 1.1% NaF
- 5000 ppm
- 2x/day
- Expectorate, but no rinsing

Fluoride Rinses & Gels

**Mod Risk**

- 0.05% NaF
  - OTC
  - 224 ppm
- 0.2% NaF
  - Rx
  - 900 ppm

**High Risk**

- 0.1% SnF
  - OTC
  - 1600 ppm
- 0.1% NaF
  - 2x/day
  - 30-60 secs
- 0.2%
  - 10 ml / 30-60 secs / daily

Professional Fluoride Treatments

- 1.23% Acidulated phosphate fluoride
  - 12,300 ppm
- 2% Neutral sodium fluoride
  - 9000 ppm
- 5% Neutral sodium varnish
  - 22,600 ppm
• Risk based
• Use of gel or varnish
• 4 minute application
• NaF & APF equally effective

1.23% APF
• pH 3.0
• 12,300 ppm
• Etching enhances uptake

2% NaF
• pH 7.0
• 9000 ppm
• Safe for esthetic restorations

• Equally effective
• 4 minute applications
• Gel vs foam formulations
Fluoride Varnish 5% NaF

**Advantages:**
- Adheres to tooth surface, maximizes contact
- High concentration in small quantity
- Safe for young children & special needs patients

**Effectiveness:**
- 22,600 ppm
- ~35-38% caries reduction
- Comparable to NaF & APF gels
Varnish Application:
- Dry field not required
- Apply to all tooth surfaces
- Floss into IP areas
- No brushing for 4 hours
- 2-4x/yr application, depending on risk
  - Continue application thru restorative treatment
  - D1206

Protective Factors
- F, Ca, PO

Calcium Phosphate Technologies
- Ca⁺⁺, PO₄⁻²

ADA Foundation ACP
- Amorphous Calcium Phosphate
- Requires 2-phase delivery system
- Highly soluble / low substantivity
- Not bioavailable after product is rinsed
- Marketed to restore surface enamel
CPP-ACP
- Casein phosphopeptides + ACP
- Binds & stabilizes ACP
- Releases during acid attack
  
  **High Risk**
  - Applied using tray, prophy cup, finger
    - Multiple applications/day

  **Low-Mod Risk**
  - Excessive root exposure/sensitivity

NovaMin®
- Calcium sodium phosphosilicate
- Bioactive glass (silica) stabilizes Ca & PO₄
- Directly forms hydroxycarbonate apatite (HCA)
Enamel Crystal Prism

- Na⁺ ions raise pH
- Releases Ca and PO₄ to tooth surface
- Forms HCA
- Continual release for up to 2 weeks

Litkowski et al 1997
Jennings et al 2004


Control Teeth
Recaldent dentrifice
Novamin dentrifice

Surface Microhardness Results

SensiStat®
- Arginine bicarbonate & calcium carbonate
- Calcium carbonate poorly soluble
- Insufficient calcium release

Protective Factors
- Increase in occlusal caries
- Slowing rate of progression

Pit & Fissure Sealants

Sealant Usage
- Increase in occlusal caries
- Slowing rate of progression
To Seal or Not To Seal?

Intact Sealants:
- Inhibit progression
- May promote regression
- Decrease bacterial colonization
- Supported by ADA & AAPD

Hendelman 1972, 1976
Going et al 1978
Metz-Fairhurst 1986
Heller et al 1995
Florio et al 2001

Current Technology

Resin-based Sealants
- Self-cure or light-cure
- Filled or unfilled
- Fluoride or no F

Other features:
- Illumination or color change
- Self-etching
- Bonding agents

Glass Ionomer Cements
- Release fluoride
- No etching required
- Less moisture sensitive

Fluoride or no F sensitive
Sealant Technique
- Adequate etching of surface
- Maintaining a dry field
- Complete coverage

Supplemented by:
- Bonding agent
- Enamel preparation
- Four-handed technique

Sealant Effectiveness
- Site Selection
  - Individual risk
  - Tooth risk
    - Anatomy
    - Caries activity
- Monitoring / re-application

ADA Recommendations for Sealant Usage
- Reduces bacteria
- Resin-based are more effective; 1st choice
- Mechanical preparation is not recommended
- Total etch bonding systems improve retention
- Use of self-etch bonding agents is not recommended
- Four-handed technique
From Yesterday to Today

Summary
Caries Management by Risk Assessment
CAMBRA
www.cda.org
www.aapd.org
www.first5.org
www.siptoday.org
www.cariesid.com

Questions
More Info:
• CAMBRA
• First 5
• Sip All Day, Get Decay
• Caries detection device