CARIRES DISEASE:
What It Is and What To Do About It

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Untreated tooth decay in permanent teeth was the most common of all 291 major diseases and injuries assessed by the 2010 Global Burden of Disease study, affecting 35 per cent of the world population.


Caries Disease

Dental caries, also known as tooth decay or a cavity, is an infection, bacterial in origin, that causes demineralization and destruction of the hard tissues of the teeth (enamel, dentin, and cementum).

An infectious microbiological disease of the teeth that results in localized dissolution and destruction of the calcified tissues.

Three requirements
1. Teeth
2. Bacteria
3. Food

The Usual Suspects

- Bacteria:
  - Over 50 bacteria now identified as potential cariogens

- Diet:
  - Americans eat 22.7 tablespoons of sugar per day
  - Americans eat 51 lbs of High Fructose Corn Syrup per year – highest in the world

- Saliva: medication induced salivary gland hypofunction
  - 70% of Americans take at least one medication
  - >50% take two or more
  - 20% take five or more
**The Usual Suspects**

- **Genetics:**
  - Numerous genes are now associated with dental caries.
  - A significant genetic association exists between dental caries of the anterior mandibular teeth and LYZL2, which codes a bacteriolysin agent thought to be involved in host defense. A significant genetic association exists between caries of the mid-dentition tooth surfaces and AJAP1, a gene possibly involved in tooth development.


- **Oral pH and saliva are closely related**
  - Medications
  - Cancer treatment – radiation and/or chemotherapy
  - Sjögren’s Syndrome or other autoimmune diseases
  - Diseases like HIV/AIDS or diabetes
  - Metabolic disturbances
  - Stress and depression
  - Physiological blockage of salivary gland ducts
  - Inadequate hydration and dehydration
  - Dietary and environmental exposure
    - Acidic foods
    - Beverages: sodas, sports/energy drinks, bottled water

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### pH of bottled water

<table>
<thead>
<tr>
<th>pH Level</th>
<th>Example of Bottled Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidity</td>
<td>NEUTRAL</td>
</tr>
<tr>
<td>pH Value</td>
<td>-</td>
</tr>
</tbody>
</table>

- **Caries Disease**
  - The process:
    - Plaque, a bacterial film, forms on the teeth.
    - Acids are produced as byproducts of bacterial metabolism.
    - Lactic acids are particularly damaging and are predominantly produced by Mutans streptococci and by Lactobacillus.
    - These acids demineralize the tooth surface.


- **Caries Disease**
  - A biofilm is any group of microorganisms in which cells stick to each other on a surface.
  - Dental caries is a complex, multifactorial disease with the oral microbial component being a biofilm.
  - The bacterial components of the biofilm can shift from healthy flora to acidogenic, aciduric bacteria due to changes in:
    - Diet
    - Saliva
    - Medications
    - Home care

The bacterial components of the biofilm can shift from healthy flora to acidogenic, aciduric bacteria.

A higher mature plaque microbial diversity was seen in caries-active compared to caries-free patients. Rothia dentocariosa and Scardovia inopinata were absent from all caries-free sites, but appeared in 50% of the caries-active sites.


The caries process
- As the bacterial components of the biofilm begin to shift from a healthy flora to an acidogenic, aciduric bacterial flora,
- The oral pH decreases, which leads to greater demineralization and destruction of tooth structure
- The critical oral pH is 5.5
  - Above pH 5.5, the process is slow and may be easily reversed
  - Below pH 5.5, the process is increasingly fast and logarithmically destructive

Featherstone JD, The science and practice of caries prevention, JADA Vol 131(7), 2000

Two key points:
1. Mutans streptococci and Lactobacillus are the most commonly found acidogenic bacteria in tooth biofilm,
   - Normally <1% of healthy oral biofilm
   - Can account for >96% of the biofilm in low pH-related oral conditions
   - But they are not the only acidogenic bacteria found

Two key points:
2. As pH decreases in the biofilm, not only do the numbers of harmful bacteria increase, but some healthy bacteria convert to harmful acid producing bacteria

A microbial community consists of a tremendous number of diverse bacteria, but functions as one organism, a ‘superorganism’….We have to get away from this monolithic one-organism picture of health, the community is the unit of study.

Buchen L, Microbiology: the new germ theory, Nature 2010

Two key points:
1. Caries is a continuous, multifactorial process of tooth demineralization and remineralization
   - This disease process can be stopped, arrested, at any point in time
   - Remineralization is possible at any point in time
     - By reversing, or limiting, the extent of salivary pH changes, teeth can be stabilized, and even remineralized
   - Until cavitation of the surface occurs, the process may be manageable with medication alone
     - This is one cornerstone of “minimally invasive dentistry”

Jenson L et al, Clinical protocols for caries management by risk assessment, J Calif Dent Assoc 35(10), 2007
Caries Disease

Sources of acid/cause of demineralization
- **Extrinsic Sources**
  - Dietary
  - Bacterial
  - Environmental
  - Medications
- **Intrinsic Sources**
  - Stomach Acid
  - Bulimia
  - Gastro-Esophageal Reflux Disease (GERD)

Sources of buffering/remineralization
- **Intrinsic Sources**
  - Saliva
- **Extrinsic Sources**
  - Dietary
  - Salivary gland hypo-function/xerostomia is a major cause of caries disease

Although caries is generally thought of as a disease of childhood or adolescence, adults clearly have caries disease. Certain groups of adults appear to have a higher incidence of caries than do other groups.
- Many elderly patients
- Many lower socioeconomic patients

Why?

More important:
Can we predict who is at increased risk for caries disease?
- Caries risk assessment (CRA), particularly in adults, is anything but an exact science...
  ...but the science is getting better!

The preventive approach to managing caries disease begins with early lesion detection

A Starting Place: Early Caries Detection

The earlier we can detect a developing lesion, the more likely we can reverse it

Caries Detection/Identification

- **Caries Identification Technology**
  - Visual inspection
  - Radiographs
  - Caries-indicating dyes
  - Visible light: Fiber optic transillumination (FOTI) and digital imaging
  - Fiber optic transillumination (DIFOTI)
  - Light-induced fluorescence
  - Laser-induced fluorescence
  - Electrical conductance
  - Alternating current impedance spectroscopy (ACIST)
  - Ultrasound caries detection
  - Optical Coherence Tomography (OCT) using near infrared (NIR) transillumination
  - Salivary diagnostics
Caries Identification Technology

Visual inspection

- Looking for defects in tooth surfaces
  - Visual
  - Feeling the surface with an explorer using light pressure
- Looking for color changes in teeth
- Reflecting light through teeth looking for optical transmission differences

Caries Identification Technology

- Only 17 – 40% correct
- Can transfer bacteria to other sites
- Can damage an intact surface
- Both false positives and negatives

“Too often I have had to perform aggressive, invasive treatment on teeth that I had believed to be healthy. Clearly, the decay had not suddenly developed to such extent, yet I had no prior suspicion of its presence…”

“From my experience I am satisfied there is much decay that is overlooked, and I believe if the truth were known, there are instances in which the best, most reliable and vigilant dental operators fail to discover decay until it is much advanced.”

Food for thought:

Dr. James S. Knapp, in a paper presented at the American Dental Association annual session, 1868

Caries Identification Technology

- Visual examination alone is not a reliable technique for detecting early caries lesions

Caries Identification Technology

- Intraoral bitewing (BW) radiographs are the most widely used
  - Digital versus conventional: no diagnostic difference
  - Easiest method to assess proximal surfaces
- ADA Radiographic Examination Guidelines (2012):
  Dentists should not prescribe routine dental radiographs at preset intervals for all patients. A thorough clinical examination, consideration of the patient history, review of any prior radiographs, caries risk assessment and consideration of both the dental and the general health needs of the patient should precede radiographic examination.

ADA Radiographic Examination Guidelines

Use clinical judgement, not routine habits
Caries Identification Technology

- Radiographic examination
  - Conclusion:
    Radiographic examination does significantly improve the reliability of visual examination for detecting early caries lesions

Neither technique alone is reliable for detecting early caries lesions

NIH consensus statement, March 2001: Current diagnostic practices (visual exam with an explorer and radiographs) are inadequate to achieve the next level of caries management in which noncavitated lesions are identified early so that they can be managed by nonsurgical methods.

Caries Identification Technology

- Radiography with computer-aided detection
  - Conclusion:
    Evidence does indicate an increased ability for practitioners to accurately distinguish between caries lesions and healthy tooth structure with this software

The computer software essentially serves as a reliable second opinion

Caries Identification Technology

- Caries-indicating dyes
  - Conclusion:
    Dyes should not be used as the sole determining factor in clinical caries removal

They are best used as an adjunct in identifying the possible extent of caries progression during caries removal.

Caries Identification Technology

- Visible light
  - Fiber optic transillumination (FOTI)
    - Reflecting light through teeth looking for optical transmission differences
    - More focused and higher intensity light increases the potential for detecting smaller, earlier caries lesions
    - May also identify fractures

Logicon Caries Detector Software

Caries Identification Technology

- **Visible light**
  - Digital imaging fiber optic transillumination (DIFOTI)
    - Same as FOTI, but an image is captured by a camera or computer
    - Image is similar to an x-ray

- **DIFOTI**
  - Advantages:
    - Much like an x-ray, but no ionizing radiation is used
    - Computer-generated images can be stored in patient database for diagnostic documentation and patient education
  - Disadvantages:
    - Visible light does not propagate very far before scattering
    - Blocked by restorations

Therefore, DIFOTI is useful in diagnosing caries in some, but not all teeth.

- **Conclusion – FOTI and DIFOTI**
  - Fiber optic transillumination, both conventional and digital, should not be used as the sole determining factor in clinical caries detection
  - A good adjunct to a careful visual examination with radiographs

- **Light-induced fluorescence**
  - Measures refractive differences between healthy and demineralized enamel
  - Areas of caries and demineralization show less fluorescence
  - A fluorescent dye can be added to enable detection of dentin lesions
  - Coupled to a computer
  - AKA Qualitative Light-induced Fluorescence (QLF)

- **Quantitative, light-induced fluorescence (QLF)**
  - Spectral Caries Detection Aid
  - Soprolife caries detection & intraoral camera
Caries Identification Technology
- Quantitative, light-induced fluorescence (QLF)
  - Changes can be tracked over time via digital measurements and images
  - Good evidence for accurate caries detection
    - Demonstrated consistency among users
    - Low false positives or negatives
    - Probably one of the most researched systems

Caries Identification Technology
- Qualitative light-induced fluorescence (QLF)
  - Conclusion:
    - QLF, while it appears to be the most accurate method currently available for detecting early caries lesions, should still be considered as a good adjunct to a careful visual and radiographic examination

Caries Identification Technology
- Laser fluorescence
  - Uses visible light in the red spectrum (655 nm wavelength)
  - Reads reflected light
    - Sound tooth structure produces low intrinsic fluorescence
    - Demineralized tooth structure increases the amount of fluorescence reflected back to the receiver

Caries Identification Technology
- Laser fluorescence
  - Demineralized tooth structure increases the amount of fluorescence reflected back to the receiver
  - The higher the reading, the greater the probability that caries is present

Caries Identification Technology
- Readings (suggested interpretation):
  - 0 – 15: no treatment needed
  - 16 – 30: preventive/restorative care depending on caries risk & recall interval
  - 31 – 99: restorative care advised
  - The higher the reading, the greater the probability that caries is present
  - High ability to detect caries

Caries Identification Technology
- Limitations:
  - Most useful for detecting occlusal caries
  - Limited to unrestored areas
  - Detects presence of caries, but not the full extent or true severity of a lesion
  - It provides an indirect measure of bacterial byproducts rather than identifying demineralized tooth structure
  - Increased false positives with stained fissures, plaque and calculus, prophylactic paste, sealants and restorations
Caries Identification Technology

Laser fluorescence
- Conclusion:
  Laser fluorescence should not be used as the sole determining factor in clinical caries detection
  - A good adjunct to a careful visual exam
    - It is best used as an adjunct in identifying the possible presence of occlusal caries

Caries Identification Technology

Laser-induced infrared photothermal radiometry & modulated luminescence
- Measures temperature change induced by infrared laser light (≤ 1°C)
  - Highly accurate measurement of tissue densities
  - Evidence indicates that it has better sensitivity for caries detection than visual, radiographic, or laser fluorescence technologies

Caries Identification Technology

Electrical conductance
- Saliva soaks into the pores of demineralized enamel and increases the electrical conductivity of that region versus that of sound enamel
  - Various systems have been introduced since the 1980's
    - Mixed success: promising, but inconsistent diagnostic predictability
    - Primarily for occlusal lesions

Caries Identification Technology

Alternating current impedance spectroscopy
- Indicates tooth structure is healthy, in early stages of decay, or already significantly decayed

Caries Identification Technology

Alternating current impedance spectroscopy
- Conclusion:
  AC impedance spectroscopy should not be used as the sole determining factor in clinical caries detection
  - A good adjunct to a careful visual exam
    - It is best used as an adjunct in identifying the possible presence of caries lesions

CAUTION: Impedance devices cannot be used on patients with cardiac pacemakers
Caries Identification Technology

- **Emerging Technologies**
  - Ultrasound caries detector
    - Uses high-frequency sound waves from handpiece
    - Receiver-computer generates an onscreen acoustic reflection of the tooth
    - Purported high sensitivity (caries present) and specificity (caries absent)

- **Emerging Technologies**
  - Optical coherence tomography (OCT) using near infrared (NIR) transillumination
    - Creates cross-sectional images of hard and soft tissue structures without ionizing radiation
    - Analogous to ultrasound imaging but uses light instead of sound
    - Has the potential to “see through” the entire tooth
    - An “optical biopsy” of any region of a tooth

- **Emerging Technologies**
  - Optical coherence tomography (OCT) Near Infrared (NIR) light transillumination
    - (via fiber optic handpiece) versus D-speed x-ray film
    - Note: Current use in ophthalmology and cardiac imaging

- **Emerging Technologies**
  - Salivary diagnostics
    - Saliva could be used to detect bacteria, enzymes, immunoglobulins, proteins, or breakdown products as a mirror not only of dental disease, but of other diseases within the body.
    - Tests could be in-office or at-home.
      - Combinations of lab-on-a-chip & immunoassay technologies are currently being tested
    - Salivary diagnostics is an area of very active research throughout the health sciences

- **Emerging technologies**
  - Optical coherence tomography
  - Ultrasound
  - Cross-sectional imaging permits the detection of the zones of caries lesions
  - Salivary diagnostics
    - These technologies may allow us to discriminate between active, progressing lesions that should be treated and arrested lesions that may be left alone
  - Summary:
    - Promising, but not yet available, caries detection technologies

- **The current state of this technology is to allow us to make more accurate early lesion detection in conjunction with our traditional careful visual examination**

- **The objective is to detect lesions as early as possible.**
  - Earlier detection opens the prospect of reversing decay and remineralizing tooth structure
Caries Diagnosis vs. Detection
- **Detection** identifies the signs and symptoms of caries disease
- **Diagnosis** is the art or act of identifying caries disease from its signs and symptoms
  - Diagnosis encompasses recognizing the presence of caries, its cause, and its prognosis
    - Why is the caries where it is?
    - What factor(s) are causing the caries?
    - What is the risk of the caries getting worse?
    - What can we do to arrest the existing caries and what can we do to prevent future caries?
- Preventive versus Reparative approach

Caries Management by Risk Assessment (CAMBRA)
- “In clinical care settings, diagnosis of caries implies not only determining whether caries is present (that is, detection), but also determining if the disease is arrested or active and, if active, progressing rapidly or slowly.”
  - Beauchamp et al., Evidence-based clinical recommendations for the use of pit and fissure sealants, Report of the American Dental Association Council on Scientific Affairs, JADA Vol. 139, March 2008

Detection of Caries = Nail in the Tire
Is there a cavity in the mouth?

Caries Disease Severity = How Many Nails in the Tire?
But why are we getting nails in the tire?

Diagnosis of Caries Disease Risk = How Many Nails are in the Driveway?
Disease is present even if there are no signs or symptoms
Is risk High, Medium, or Low?

Caries Risk Assessment

Slide courtesy of Dr. Kim Kutsch
Caries Management by Risk Assessment (CAMBRA)

- Ultimately, dental caries is a transmissible, bacterial infection
  - Simply removing a carious lesion does NOT remove the bacteria in the mouth that caused the lesion
  - However, removing and restoring carious lesions, in conjunction with anti-caries interventions, is an important first step in caries management.

Caries Management by Risk Assessment (CAMBRA)

- Determining the caries risk of an individual is an important step in caries management equal to restoration of cavitated lesions
  - Risk assessment requires evaluating the number and severity of risk factors a patient has, and how those risks are counter-balanced by protective factors.
  - Caries risk assessment is not a precise science, but it is a valuable tool that enables us to customize preventive strategies for each individual patient.

Caries Management by Risk Assessment (CAMBRA)

- The best risk indicators of caries disease are:
  - The number of existing caries lesions
  - The number of restored or missing teeth
  - But what are the risk factors?

Caries Management by Risk Assessment (CAMBRA)

- Risk factors: anything that lowers the oral pH
  - Poor oral hygiene
  - Diet high in fermentable carbohydrates
  - Low salivary flow
    - Due to habits, disease, or medications
  - Or attracts plaque
  - Exposed root surfaces
  - Orthodontic or removable appliances
Caries Management by Risk Assessment (CAMBRA)

Caries risk is a balance between caries-inducing and caries-preventing factors:

**Inducers:**
- Poor oral hygiene
- Multiple caries lesions
- Multiple restorations
- Low fluoride availability
- Low salivary flow
- Exposed root surfaces
- Ortho &/or removable appliances

**Preventors:**
- Good oral hygiene & dietary habits
- OTC fluoride toothpastes, rinses, and gels
- Rx fluoride toothpastes, rinses, and gels
- Rx antifungal rinses
- More frequent recall appts.

The Caries Balance: which way will it tip?

**Bacteria (Ms & lactobacillus)**
- Dietary components & frequency (fermentable CHO and acidic foods)
- Other sources of acid (gastrointestinal, environmental)
- Salivary dysfunction
- Fluoride
- Saliva (flow & components)
- Dietary components (protective)
- Antimicrobials (chlorhexidine, iodine)
- Xylitol

CARIRES △ NO CARIRES

Adapted from Dr. John Featherstone

Caries Disease Progression

Featherstone, Young & Wolf, 2007

Risk factors predispose people to caries disease:
- Acidogenic bacterial load and salivary competence can be measured
  - These measurements are analogous to measuring pocket depths, attachment loss, etc. to assess periodontal disease
  - These assessments should be done as early in the exam process as possible
Pacific CRA Form

- Protective factors:
  - We want to maximize these factors
  - What behaviors or products can we recommend to our patients to increase these factors?

Salivary Assessment

- There are four salivary assessments that can be performed
  1. Resting flow rate
     - Low flow is seen with patients with thick,ropy/stringy saliva, or very frothy,bubbly saliva
  2. Stimulated flow rate
  3. Resting pH
  4. Stimulated pH

These four salivary assessments are not routinely done on every patient.

Salivary Analysis

Saliva: Resting Flow Rate

- Ask questions:
  - Does the patient feel that they tend to have a dry mouth all the time?
  - Depends on the patient’s level of activity and degree of hydration
  - Dry, then apply tissue or gauze to the lips for 1 minute to measure resting flow of the minor salivary glands

Saliva: Stimulated Flow Rate

- If the resting flow rate is low, the stimulated should be checked as well
- Ask questions:
  - Does the patient feel that they tend to have a dry mouth when they eat?
  - Depends on the patient’s degree of hydration
- To measure:
  - Patient chews paraffin pellet for 5 minutes
  - Spits all saliva into cup
  - Flow rate:
    - Normal = ≥1 ml/min.
    - Xerostomic = <1 ml/min.

Measuring Salivary pH

- Resting pH
  - Have patient spit once into a cup before starting an oral exam
  - Dip pH paper into the saliva
- Stimulated pH
  - Dip pH paper into the cup if collected saliva for stimulated flow rate measurement
  - Or have patient spit once into a cup after completing the intraoral exam
Measuring Bacterial Load – Old Way
- CRT (Caries Risk Test)
  - Take saliva collected from stimulated flow rate test
  - Pour onto selective media culture slides
  - Incubate for 48 – 72 hours

14 yr old with EXTREME Caries Risk

Pre-treatment CRT test

LB MS

3 months later: after initial course of antimicrobial rinses. Final quadrant yet to be restored.

Case courtesy of Dr. Graeme Milicich

Measuring Bacterial Load – Old Way
- Compare the density of Colony Forming Units (CFUs) at caries recalls to the baseline density

14 yr old with EXTREME Caries Risk

Pre-treatment CRT test

LB MS

5 months later - all cavities restored and a 2nd course of antimicrobial rinses

There is no quick fix!

Case courtesy of Dr. Graeme Milicich

Measuring Bacterial Load – New Way
- As pH decreases in the biofilm, not only do the numbers of harmful bacteria increase, but some healthy bacteria convert to harmful acid producing bacteria
- Acid producing bacteria in the biofilm generate ATP
- The ATP meter measures the bioluminescence of the ATP
  - This is an indirect measure of the acidogenic bacterial load

CariScreen Caries Susceptibility Testing Meter and Swab
- Correlates to caries risk level
  - >1500 = high load/risk
  - <1500 = low load/risk
- Get results chair side in only 1 minute

Measuring Bacterial Load

- Bacterial testing
  - Initial test provides a baseline reading of acid-producing bacterial load
  - Subsequent tests at caries recall appointments evaluate the success of intervention therapies
    - Behavior changes
    - Chemical recommendations and prescriptions
  - Or changes in the patients health or preventive capabilities

Pacific CRA Form

- Based upon all of the data we have gathered, a caries risk level is assigned:
  - Low
  - Moderate
  - High
  - Extreme (xerostomic)

The point of assigning a risk level is to help you decide how to treat the patient

Caries Risk Management

- Brushing twice daily with a fluoride-containing dentifrice is one of the most effective ways to control dental decay
- High bacterial challenge/low oral pH overcomes the therapeutic effects of fluoride
- Fluoride cannot remineralize tooth structure in a low pH environment

Caries Risk Management

- What interventions will best help the patient?
- And how can we best assess the outcomes of our attempts to treat caries disease?
- We need to establish some sort of baseline measure of the disease state to compare against:
  - The past: DMFT
  - The present (and the future): Salivary diagnostics
    - Saliva flow rate and buffering capability
    - Bacterial counts of acid producing species

Caries Risk Management

CAMBRA Products

- Chlorhexidine rinse – antibacterial
- CariFree Treatment Rinse – antibacterial, pH neutralizer
- CariFree Maintenance Rinse – pH neutralizer, xerostomia
- Fluoride rinse (ACT) - remineralization
- CariFree Boost Spray – pH neutralizer, xerostomia
- Baking soda toothpaste &/or rinse – pH neutralizer, xerostomia
- Xylitol mints (or gum) – xerostomia (salivary flow stimulant), antibacterial; pH neutralizer (CariFree gum)
- Fluoride varnish, MI or MI Plus Paste – desensitizer, remineralization
- 5,000 ppm Fluoride toothpaste – remineralization
Treatment Rinse (CariFree CTx4)
- Mix equal amounts of A & B (~10 ml) and swish for 1 minute once or twice a day.
- Has an extremely elevated pH of 10.0 - 11.0, which makes the biofilm environment inhospitable for acid-loving bacteria.
- Active ingredient: Sodium hydroxide and sodium hypochlorite.
- Other ingredients: Fluoride and 11% xylitol; alcohol free.

Chlorhexidine Gluconate
- Rinse with ½ oz (15 ml) for 1 minute once or twice a day for one week.
- Use a fluoride product for the next three weeks.
  - Do NOT use fluoride and CHX together.
  - Repeat each month.
- pH 5.0 – 7.0.
- Active ingredient: 0.12% chlorhexidine gluconate; ~12% alcohol.
- Brands: Peridex, PerioGard.

How to Use Antimicrobial Rinses
- Continue to use until caries control is completed and bacterial counts are low.
- Apply antimicrobials intensely, on a short term basis, to a therapeutic endpoint.
- Set a “Caries Recall” dependent upon what you have prescribed and patient motivation.
  - Usually want to do another ATP measure at 1 month.
  - Repeat as frequently as you feel is appropriate.

Summary of Antibacterial Rinses
- Treatment Rinse (CariFree CTx4)
  - Use once or twice a day until gone.
- 0.12% Chlorhexidine (Peridex, PerioGard)
  - Use once or twice a day for 1 week per month.
  - Does not work against lactobacillus.
  - May cause staining, increased calculus formation.
- Iodine (hospital dentistry)
  - Requires long contact time.
- None of them taste very good.
  - How you educate each patient on the importance of their use is crucial.

Maintenance Rinse (CariFree CTx3)
- Daily use to prevent the dental caries infection from returning.
- Rinse with 10 ml for 1 minute.
  - Usually use twice a day.
  - For xerostomia: use more frequently, especially after snacking.
- pH 8.0.
- Active ingredient: 0.05% NaF.
- Other ingredients: 25% xylitol (3 grams/dose); alcohol free.

OTC Fluoride Rinses
- 0.05% NaF rinses are very effective in high caries risk patients when used once or twice daily for one minute, in combination with a fluoride-containing dentifrice.
- Rinse with ½ oz. for 1 minute 1x or 2x daily (more often if xerostomic).

**High Fluoride Toothpaste**

- 1.1% Na Fluoride = 5000 ppm
- Pea-sized amount twice a day
- Not for young children

**Prospec™ MI Paste** by GC America

- What it is:
  - MI = Mineral Imbalance
  - Water-based, sugar-free paste
  - Contains RECALDENT™ (CPP-ACP)
    - CPP = Casein Phosphopeptide
      - Binds to enamel, biofilm, and soft tissues
    - ACP = Amorphous Calcium Phosphate
      - Calcium & phosphate ions in non-crystalline state
    - Note: MI Paste does NOT contain fluoride; MI Paste Plus does contain fluoride

**MI Paste Plus**

- What it does:
  - CPP provides stable delivery vehicle for ACP free calcium & phosphate ions
    - Diffuse back into subsurface demineralized enamel for remineralization
  - Occludes open dentinal tubules
  - Reduces adherence of certain plaque bacteria
  - Mimics salivary buffering of healthy saliva

**High Fluoride Toothpaste**

- High fluoride concentration (5,000 ppm F) toothpaste is more effective than regular F toothpaste (1,100 ppm) in high risk individuals
  - Especially effective against root caries
  - Baysan A et al, Reversal of primary root caries using dentifrices containing 5,000 and 1,100 ppm fluoride, Caries Res 35(1), 2001
  - However, caries progression still occurred in many subjects even with high concentration fluoride use

- Extra Calcium and Phosphate
  - Helps remineralization, root sensitivity, and pH neutralization
  - Xerostomia/Salivary Gland Hypofunction (SGH)
  - Rub on with a clean finger several times a day and/or use a “bleaching tray” overnight
  - MI Paste Plus = with fluoride

- Uses:
  - Decrease tooth sensitivity
  - Prevention and remineralization of early caries lesions
  - Buffering of saliva in high caries risk patients
    - Should NOT be used on patients with milk protein allergies
    - Do course of MI Paste Plus before
      - Fluoride varnish application
      - Glass ionomer restorations
**MI Paste Plus**

- **Decrease tooth sensitivity:**
  - For exposed root surfaces
  - Due to whitening procedures
  - Patients with erosive diseases
    - GERD
    - Bulimia
    - Pregnancy
  - Apply with cotton swab or finger tip
    - Leave for 3 minutes, don’t rinse; may be swallowed or expectorated
    - Repeat 2x/day

**MI Paste**

- **Buffering of saliva in high caries risk patients:**
  - Resting saliva pH vs. stimulated flow
  - Xerostomia due to medications, chemo- or radiation therapy
  - Apply 2x/day after brushing
    - Combine with dietary modifications, fluoride toothpastes, chlorhexidine rinses, glass ionomer restorations

**Fluoride Varnish**

- Usually white or clear
- 5% Na Fluoride = 22,600 ppm
- Slowly releases fluoride for months
- Safe for infants and children
- Should be considered after cleanings

**Fluoride Varnish and Gels**

- Office-applied fluoride varnish and F1 gel (≥ 5,000 ppm F1) 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
  - Recommend 3 – 4 applications a year for high risk patients

**Evidence-based clinical recommendations for professionally applied topical fluoride:**

1. Fluoride gel applied for 4 minutes or more is effective
2. Fluoride varnish applied every 6 months is effective
3. Two or more applications of fluoride varnish per year are effective in high caries risk individuals
4. Office topical applications provide no added benefit for low risk individuals
Acidulated Fluoride Gels

- 1.23% Acidulated Fluoride gels:
  - Fluorident, Protect, Gel-Cam
  - 4 minutes in-office via tray application
  - At-home patient use NOT RECOMMENDED

Xylitol Gum or Mints

- A naturally occurring sugar
  - Slowly absorbed so lower caloric intake than other sugars
  - Does not require insulin for metabolism
  - Maintains neutral oral pH
  - Decreases adhesion of bacteria to teeth
  - Bacteria cannot metabolize it
  - Therefore, it is strongly anti-acidogenic bacteria & decay

Xylitol Gum or Mints

- Gum
  - Each piece is 1 gram of xylitol
  - Need 5-10 grams per day
  - 5 – 10 pieces each day is ideal

- Mints
  - Each piece is 0.5 grams of xylitol
  - 10 – 20 pieces each day is ideal

Boost Spray (CariFree CTx2)

- Recommended for xerostomic patients
  - Calcium hydroxide with pH 9.0
  - Also contains 35% xylitol, and glycerine
  - Use 2 - 3 sprays as often as needed
  - Raises pH and prevents demineralization
  - Convenient size to fit in pocket

Products For Xerostomia

And sip water frequently; can mix 1 teaspoon of baking soda in 8 oz. of water as a simple pH neutralizer

Caries Management by Risk Assessment (CAMBRA)

- Use chemical and behavioral therapies based upon clinical observations and evidence
  - What interventions will best meet the patient’s needs?
  - What interventions is the patient motivated to use?
    - Start with one recommendation and check at recall (1 month?)
    - Add other recommendations as patient compliance/motivation warrants
    - Reassess and alter as needed over time
Caries Management by Risk Assessment (CAMBRA)

Targeted antibacterial and fluoride therapy based on salivary microbial and fluoride levels favorably altered the balance between pathological and protective caries risk factors.


Caries Management by Risk Assessment (CAMBRA)

Suggested risk-based interventions for adults

Office-based interventions for low risk
- 6 month (+) recall exam and prophy
- Reinforce individualized OHI
- BW radiographs every 12 to 18 months

Home-based interventions for low risk
- Brush with OTC fluoride dentifrice 2x daily

Complete a new caries risk assessment yearly

Caries Management by Risk Assessment (CAMBRA)

Suggested risk-based interventions for adults

Office-based interventions for moderate risk
- 3 to 6 month recall exam and prophy
- Apply fluoride gel or varnish at every recall visit
- Review dietary habits and oral hygiene instruction
- Restorative treatment (MID) as needed
- BW radiographs every 12 months

Home-based interventions for moderate risk
- Brush with OTC fluoride dentifrice 2x daily
- Rinse with OTC fluoride rinse (0.05% NaF) twice daily
- Xylitol gum or candies 4x daily

Caries Management by Risk Assessment (CAMBRA)

Suggested risk-based interventions for adults

Home-based interventions for high risk
- Brush with 5000 ppm F prescription toothpaste
- Chlorhexidine rinse (0.12%) 1x daily for one week every month
- Fluoride rinse (0.05% sodium fluoride) 1 – 2x daily for remaining three weeks every month
- Xylitol gum or candies 4x daily
- Use sugar substitutes, e.g. xylitol or sorbitol

High and moderate caries risk patients should be re-evaluated and re-tested at each recall appointment.
- The success of all applied interventions needs to be reassessed at each recall appointment.

Caries Management by Risk Assessment (CAMBRA)

Extreme Caries Risk Individuals
(High Risk plus severe hyposalivation – Measured saliva flow rate less than 0.5 ml/minute)
- Same as for high risk individuals PLUS:
- Medical consult on medications or disease or medical treatment status
- Baking soda rinse 4x daily (2 teaspoons in 8 ounces water)
- Consider fluoride trays for home use (1.1% neutral NaF gel) daily
- Consider calcium phosphate home use gel (MI Paste)
- 3 months caries recall: reapply F varnish and repeat risk assessment and bacteria test
Caries Management by Risk Assessment (CAMBRA)

- Suggested risk-based interventions for adults
  - Interventions for low salivary flow patients
    - Avoid acidulated fluoride products
    - Educate patient about the caries process and the role of saliva in prevention
    - Recommend xylitol gum or mints to stimulate saliva flow
    - Recommend frequent sips of water
    - Rinse frequently with baking soda suspension in water (2 teaspoons in 8 oz. water)
    - Baking soda dentifrice will neutralize oral acids
    - ACT fluoride rinse daily (has no alcohol)

- Diet Counseling: preventive strategies
  - Assess the patient’s dietary habits
  - Analyze eating and sugar exposure patterns and types of foods
    - Dietary diaries
    - Recall interviews
  - Reduce the frequency of sugars/carbohydrates
  - Suggest healthy alternatives

- Caries risk assessment is a valuable tool that enables us to better tailor preventive strategies for each individual patient.
  - Simply stated, each patient’s preventive program must be custom fit to his or her individual risk areas or needs, just like all other dental treatment.


Dietary Counseling

The plaque pH after 30 minutes was higher in the cheese group than that of the milk and yogurt groups, both of which showed a pH toward baseline (neutral pH) after 30 minutes. These results suggest that cheese has the highest anticariogenic property among the dairy products studied, and that milk and yogurt can be considered as noncariogenic.


Caries risk assessment is to treat the disease, not just the symptoms

We strive to detect caries lesions early enough to reverse or prevent progression

- Use high fluoride-releasing agents to
  - Remineralize non-cavitated lesions
  - Prevent progression of incipient lesions or development of new lesions
  - Arrest existing frank decay
Management of Caries Lesions

- However, symptoms such as cavitated lesions do need to be treated
- Use minimally invasive restorative techniques to conserve as much tooth structure as possible
  - Requires a thorough knowledge of new dental materials and their proper use


Occlusal Caries = Pit and Fissure Caries

- 44% of caries lesions in primary teeth are found in the pits and fissures of molars
- 90% of caries lesions in permanent posterior teeth are found in the pits and fissures


Pit and Fissure Caries

The hardest to detect visually or radiographically
- Hard to clean
- Hard to monitor remineralization
- Requires most aggressive treatment for prevention
- Use caries biopsy?
- Use sealant?

Steinberg S. A modern paradigm for caries management, Part 1: Diagnosis and treatment, Dentistry Today, Feb 2007

Classification of Caries Lesions

- Useful when assessing severity of a lesion
- International Caries Detection and Assessment System (ICDAS) for occlusal caries

ICDAS code

- Classification is particularly useful for initial charting of lesions
- Describes a well defined, standardized baseline status
Pit and Fissure Sealants:
- Placement of resin-based sealants on the permanent molars of children and adolescents is effective for caries reduction
  - At 1 year = 86% reduction
  - At 2 years = 78.6% reduction
  - At 4 years = 58.6% reduction
  - If reapplied as needed, at 4 years = 76.3% reduction
    - 65% reduction at 9 years with no reapplication during last 5 years


Pit and Fissure Sealants:
- Sealants can prevent the progression of early noncavitated carious lesions
  - Placement significantly reduces the percentage of such lesions that progress in children, adolescents and young adults for as long as 5 years after placement
    - Bacteria do not increase under sealants
    - Sealants over existing caries lower viable bacterial count by at least 100-fold
    - Reduce number of lesions with any viable bacteria by 50%


Pit and Fissure Sealants:
- Fissure widening versus no prep
  - “Caries biopsy” recommended for ICDAS Class 3
    - Determine full extent of caries
    - Remove demineralized enamel
    - Better fill of material into fissure
  - Fissure bur versus air abrasion
    - Evidence inconclusive; both work
    - Acid etching recommended after either

Pit and Fissure Sealants

Resin versus glass ionomer sealants

- Filled resins
  - Most wear resistance
  - Potentially best retention
    - Significantly improved retention with use of rubber dam

- Unfilled resins
  - Retention similar, but less wear resistance

- Glass ionomer
  - Less wear resistance
  - Lower retention rate

Sealants

Resin versus glass ionomer

- Glass ionomer
  - Better retention with difficult isolation
  - Better retention with partially erupted teeth
  - Better retention with immature enamel formation
  - But are retention and wear resistance really the essential merit of a sealant?
  - What about prevention?

- What about prevention?
  - Has continuous fluoride release via recharging
  - Reduced caries incidence around GI sealants
  - Use as a “temporary” restorative material and surface protectant where you want to deliver long term fluoride release

The Approximal Lesion = White Spot Lesion

The best for remineralization...as long as it is not cavitated
Management of Approximal Lesions

How likely is it that an approximal lesion has a cavitated surface?

Pitts & Rimmer used a classification system of E1, E2, D1, D2 only:

- E0: Radiographic E0 (outer 1/2 enamel)
- E1: Radiographic E1 (inner ½ enamel)
- D1: Radiographic D1 (outer 1/3 dentin)
- D2: Radiographic D2 (middle 1/3 dentin)
- D3: Radiographic D3 (inner 1/3 dentin)

Pitts NB & Rimmer PA. An in vivo comparison of radiographic and directly assessed clinical caries status of posterior approximal surfaces in primary and permanent teeth. Caries Research, 1992

Management of Root Caries Lesions

- Increased incidence in the elderly
- Difficult to restore with contemporary materials
- Glass ionomer
  - Best retention to dentin
  - Best retention for difficult gingival isolation situations
  - Esthetically inferior to resins
  - Resin modified GI vs. regular GI


Chadwick BL & Evans DJ, Restoration of class II cavities in primary molar teeth with conventional and resin modified glass ionomer cements: A systematic review of the literature, Eur Arch Paediatr Dent 8(1), 2007

Management of Root Caries

- An Exposed Root is a Root at Risk
- Prevention of root caries is the best course
- Fluoride inhibits demineralization and enhances remineralization
- Fluoride varnishes
- Fluoride rinses and/or high fluoride toothpaste
- MI paste plus
- Buffer pH in xerostomic/SGH patients
- Baking soda rinses
- Xyitol gum or mints
- Connective tissue grafting to cover the exposed root surface

Glass Ionomers

A good option for root caries in non-esthetic zones
Management of Caries Lesions

- Use minimally invasive restorative techniques to conserve as much tooth structure as possible
  - Bonded materials maintain tooth strength

- Partial versus Complete caries removal
  - Ideal treatment is to remove all soft, mushy infected dentin while leaving any hard stained affected dentin
  - However, if complete removal of infected dentin poses a risk of unnecessary pulp involvement, infected dentin may be left
    - Cariogenic bacteria, once isolated from their nutrient source, either die or remain dormant
  - It is essential that the lesion is well-sealed off from the oral environment
    - Removal of demineralized tooth structure from the margins is required
  - Glass ionomer restorative materials maximize adhesion

- Is it necessary to remove all carious tooth structure?
- Numerous studies indicate that there are significant advantages to incomplete caries removal, especially in the treatment of deep caries
- If the restoration can be completely sealed
  - Conservative approaches followed by bonded restorations diminished bacterial loads and did not have higher restoration failure rates
  - Showed significant risk reductions for pulpal exposure and post-operative pulpal symptoms
  - A sealed restoration should arrest caries progression, but evidence is currently inconclusive

- Enamel tooth structure
  - Enamel is porous
    - By volume: 85% carbonated apatite, 3% lipids & proteins, 12% water
  - Bacteria are too large to fit through the enamel pores of an intact surface, but organic stains can enter
  - Acids, however, can enter the pores and cause demineralization of enamel
    - Demineralization = affected enamel
  - If left untreated, demineralization leads to cavitation
    - Bacteria can enter cavitations, causing bacterial infection of the enamel
    - There is always a layer of demineralized affected enamel separating healthy enamel from infected enamel

- Stained, affected dentin is not infected if the overlying enamel is intact
  - This lesion can be remineralized, and the enamel will be more caries resistant than the original surface

- Dentin tooth structure
  - Dentin is very porous
  - Acids penetrating through the enamel cause demineralization of the underlying dentin
  - Dentin demineralizes much more rapidly than enamel
    - Demineralized dentin = affected dentin
    - Affected dentin is typically stained, but relatively hard
  - As cavitation progresses from the enamel into the dentin, bacteria begin to invade the dentin
    - Infected dentin is soft and mushy
    - Bacteria survive via their link with nutrients in the saliva penetrating through the cavitated enamel and passing into the dentin tubules

- Stained, affected dentin is not infected if the overlying enamel is intact
  - This lesion can be remineralized, and the enamel will be more caries resistant than the original surface

Young DA et al, Current Concepts in Cariology, Dental Clinics of North America 54(3), July 2010
Thompson V et al, Treatment of deep carious lesions by complete excavation or partial removal: A critical review, J Am Dent Assoc 139(6), 2008
Management of Caries Lesions

#15: Pre-op bitewing shows no occlusal caries lesion (ICDAS 3)

We will try to preserve the marginal ridges as much as possible.

Management of Caries Lesions

Most infected dentin has been removed, but some remains in the central pit. A glass ionomer liner was placed over the central pit prior to resin restoration.

Management of Caries Lesions

The initial lesion appearance. Caries removal in progress.

Management of Caries Lesions

- Caries removal is stopped to avoid the pulp.
- Infected dentin remains, but we have clean, hard margins established all the way around the preparation.

Management of Caries Lesions

- Partial versus Complete caries removal
  - These techniques were originally developed for use in less-developed parts of the world where traditional access to dental care is difficult.
    - Atraumatic Restorative Technique (ART)
    - Interim Therapeutic Restorations (ITR)
  - These techniques are increasingly becoming part of the minimally invasive philosophy in developed countries.
    - Becoming part of contemporary dental practice in the U.S.
  - Provide long term resistance to continued or recurrent caries disease destruction of tooth structure.

Case courtesy of Dr. Hien Ngo.


Management of Caries Lesions

- Partial versus Complete caries removal
  - ART/TR restorative techniques
    - Ideal treatment is to remove all soft, mushy infected dentin while leaving any hard stained affected dentin
    - However, if complete removal of infected dentin is not necessary, particularly if this poses a risk of unnecessary pulpal involvement
    - It is essential that the lesion is well-sealed off from the oral environment
      - Removal of demineralized tooth structure from the margins is required
      - Conventional GI materials may be used as a liner beneath a resin restoration
      - Resin modified GI materials may be used for the entire restoration

- Ozone treatment ($O_3$): a very potent oxidizer
  - Ozone gas may be used as a preparation cleanser
    - Exposure to ozone gas rapidly disinfects carious dentin and stops the decay process in previously infected tooth structure

To Summarize

- The object of CAMBRA is to treat the disease, not just the symptoms
  - Use chemical and behavioral therapies based upon clinical observations and evidence
    - What interventions will best meet the patient’s needs?
      - Reassess and alter as needed over time: Caries recalls
    - What interventions is the patient motivated to use?
      - Reassess and alter as needed over time: Caries recalls
  - Detect carious lesions early enough to reverse or prevent progression
    - High fluoride-releasing agents to remineralize non-cavitated lesions
    - High fluoride-releasing agents to prevent progression of incipient lesions or development of new lesions
    - High fluoride-releasing agents to arrest and better manage existing decay
Caries Management by Risk Assessment (CAMBRA)

The object of CAMBRA is to treat the **disease**, not just the symptoms

- Use minimally invasive restorative techniques to conserve as much tooth structure as possible
- Requires thorough knowledge of new dental materials and their proper use
- This is a challenge, but isn’t that **exciting**?
- Use an evidence-based approach to assess materials and techniques

Like most infectious diseases, dental caries can manifest bursts of activity with periods of quiescence

Caries disease is a chronic infection; its prevention requires constant vigilance

- Schedule aggressive caries recall appointments
- Have risk factors shifted?
- What is the caries balance now?

The success of CAMBRA implementation lies

- In educating our patients of the value of this service to their oral and overall health
- In the dedication of the entire dental office team to teaching and providing this service

CAMBRA encompasses treatment of the entire patient

- By earlier, potentially more conservative treatments
- By lifelong preventive measures

Patient Education

- When patients understand the risk factors and possible outcomes, they are empowered to take control of their dental needs and future

As a result, patients are more accepting of your preventive and treatment recommendations as presented

- Patients place a greater value on the service available from your whole dental team

Get the whole dental team involved by delegating duties

- **Dental hygienists**
  - Periodontal risk assessment
- **Dental assistants**
  - Caries risk assessment and photographs
- **Both DHs and DAs**
  - OHI and caries intervention protocol education
- **Office manager and front office personnel**
  - Reinforce need for regular check-ups/monitoring
  - Answer patient questions, assist with computer-based patient learning system programs

Patient Education by the Dental Team

- It is in everyone’s best interests to improve each patient’s knowledge of oral health in general, and of their own oral health or disease state in particular.

Advantages

- Creates rapport and trust that your office wishes to serve the patient’s needs = patient trust
- Creates value in the patient’s mind for the services they need = greater treatment acceptance
- Patient’s can make an **informed decision** about their health care = informed consent
**Caries Management by Risk Assessment (CAMBRA)**

- Patients need to understand
  - They have a risk of disease
  - Their risk of disease can change over time
  - There are steps they can take to reduce and/or minimize their risk over time
  - You and your office team are there to help them
- The goal is to help the patient realize their role in controlling treatment outcomes, and the need for regular check-ups/monitoring
  - Empower your patients

**Caries Management by Risk Assessment (CAMBRA)**

- Many patients want to improve the appearance of their teeth
  - Bleaching
  - Orthodontics
  - Crowns and veneers
  - Bridges and implants
- But they are reluctant to do so because they keep getting new “cavities”

Help them control their dental diseases and they will seek these additional services FROM YOU

**Caries Management by Risk Assessment (CAMBRA)**

- For many patients dentistry is a discretionary expense
  - They will not invest in something they do not understand
  - They will not invest in something they believe will fail
- Treatment plan presentation
  - How can you increase treatment plan acceptance?
    - In a word…EDUCATION
    - The more a patient knows and understands about their oral health/disease, and the more they can do to control their oral health, the more value your treatment plan will have to them

**Caries Management by Risk Assessment (CAMBRA)**

- By taking the time to educate your patients, you will
  - Increase their satisfaction in your practice
  - Increase their acceptance of needed care
  - Increase their desire for optional care
  - Increase their referrals to your practice
  - Increase your satisfaction with your practice
    - You are providing your patients with the best care
    - Your practice will be more productive than ever

**It’s a win – win situation!**

**Caries Management by Risk Assessment (CAMBRA)**

**Can you afford the time?**

How can you afford NOT to take the time?

**It’s a win – win situation!**

**Resources**

- February and March 2003 Journals of the California DA
- October and November 2007 Journals of the California DA
- October and November 2011 Journals of the California DA
- The CDA Foundation at www.cdafoundation.org/journal