A Modern Paradigm for Caries Management, Part 1: Diagnosis and Treatment

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PROGRAM INTRODUCTION

**Learning Objectives:**

*After participating in the activity, the individual will learn:*

- the natural history of and risk factors for dental caries, and
- a modern diagnostic and treatment approach for dental caries management.

**About the Authors**

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**Introduction:**

Many clinicians approach the management of dental caries from a surgical perspective, i.e., treating cavitations with restorations. Caries is not evenly distributed in the population; 20% of the people in the United States have 60% of the tooth decay. However, to identify and treat this 20% of the population, the paradigm must shift from a purely surgical approach to a combined medical-surgical approach. This paradigm begins with the realization that caries is an infectious disease process. This 2-part report will help clinicians understand and apply a modern paradigm for caries management. Part 1 will focus on diagnosis and will introduce treatment concepts. Part 2 will focus on practical protocols for caries management.
The first step toward an improved paradigm of caries management is understanding the concept of prognosis. In medicine, if a patient is given the diagnosis of cancer, the next question is often, will I die? In other words, what lies ahead? Clinicians must understand the prognosis of the caries disease process and have familiarity with the natural history and epidemiology of caries. How does caries progress? When is the lesion inactive? Can caries heal? Are currently unaffected teeth at risk? When should we intervene with treatment? Should treatment be surgical (restoration) or medical (antimicrobial agents and fluoride)? Since caries is a disease process that changes over time (it can continue to worsen, can stabilize, or can even improve [remineralization]), clinicians want to know the current status of the lesion. How can this be determined? What is the prognosis for each tooth? What is the prognosis for the entire dentition? When prognosis is added to diagnosis, treatment planning is improved.

PROGNOSIS
DEFINING DENTAL CARIES

Dental caries can be defined using two criteria. First, caries is a bacterial infection caused by specific acidogenic bacteria in the plaque biofilm. Second, caries is a multifactorial process of tooth demineralization and remineralization, which until cavitation is reversible. Caries is the point at which the process of bacterial demineralization of tooth structure overwhelms the patient’s ability to remineralize tooth structure.9 This currently involves considerable professional judgment. Caries detection is an activity during which the clinician looks for objective findings on individual teeth using visual/tactile senses, possibly with assistance from technology. Caries assessment should be used to determine a current diagnosis and prognosis for the future.

A Reversible Multifactorial Process

Cavitation can be considered an event, the end-stage of a continuum. However, the caries process, which begins long before cavitation, is multifactorial, with contribution from bacteria, sugar (fermentable carbohydrates), saliva, and fluoride. Past dental and medical history also are factors to be considered.10 Since caries can be defined as a process, the key question becomes, is it reversible? Can caries heal? In the early stages, dental caries is reversible.11 All dentists have seen initial white-spot lesions on teeth after orthodontic therapy that are solid one year later, as well as ìarrestedî lesions on proximal tooth surfaces following an extraction. How is this possible?

The development of dental caries is a dynamic process of demineralization of the dental hard tissues by the acidic byproducts of bacterial metabolism, alternating with periods of remineralization.12 The bacteria in the plaque on the intact tooth surface metabolize the available sugar, with lactic acid as the most important acidic byproduct. Acid penetrates the solid yet microscopically permeable tooth surface, removing calcium and phosphate from the subsurface tissue, resulting in demineralization. The result is an initial white-spot lesion.

Remineralization can and does occur. Saliva can buffer the low pH in the plaque, and with the raised pH, calcium and phosphate are deposited, remineralizing the tooth. The key is the intact tooth surface. If it remains intact (noncavitated), remineralization is possible. After cavitation, remineralization is unlikely.13-16 The question for the clinician then becomes, is the lesion remineralizing, or is the caries process continuing? What is the caries activity?

An active lesion is progressing toward cavitation (demineralizing). An inactive lesion is not progressing or is healing (remineralizing). Therefore, determining the prognosis of the carious lesion before cavitation is the key. In the past, it was thought that the lesion was continuously progressing. We now know that the natural history of a carious lesion is characterized by periods of demineralization and remineralization. Subsurface demineralization eventually causes the collapse of the overlying tooth surface, creating cavitation. At this point, surgical intervention (restoration) must be used. Until then, medical intervention is possible.13-16

The status of any lesion is based on color, surface texture, and longitudinal radiographic findings. White-spot lesions may be considered active if they appear chalky, nonglossy, and feel rough with an explorer. Inactive lesions have a relatively intact surface that is shiny and hard and feels smooth with an explorer. Inactive lesions may be stained a darker color17-19 (Figures 1 to 3). Longitudinal radiographs, instead of cross-sectional findings, aid in the assessment of lesion status. An explorer should be used
only to evaluate white-spot lesions. A light touch should be employed with the explorer parallel to the surface of the tooth. Use of the explorer in a perpendicular direction with force could cause iatrogenic cavitation. Explorer use in occlusal grooves is contraindicated, as iatrogenic damage can be produced that will favor continued lesion development.20 In the case of occlusal grooves, there is no diagnostic benefit from the visual plus tactile method versus the visual only method.21

New diagnostic devices are also available. Use of QLF, Inspektor Pro (OMNI Preventive Care), or DIAGNOdent (KaVo America) can be helpful. QLF utilizes the scattering properties of visible light to detect tooth/mineral irregularities. When the tooth is illuminated with the blue light, the light travels through the relatively transparent enamel with a low chance of absorption and a high probability of refraction. The light contacts intact enamel and dentin, causing a yellow/green fluorescence in random directions that is detected by the camera in the QLF handpiece. Early lesions appear as dark spots or shadows on the fluorescent image, while bacterial byproducts appear red on the screen.22

DIAGNOdent employs laser technology to detect and quantify hidden or subsurface caries by measuring laser fluorescence within the tooth structure. Light is emitted from a solid-state laser with a wavelength of 655 nm. At this specific wavelength, clean, healthy tooth structure exhibits little or no fluorescence, resulting in very low readings on the display. Bacteria from the caries process produce porphyrins that fluoresce. Readings of 30 or more, along with visual evidence, are an indication of the need for surgical intervention.23 Lower readings indicate the need for conservative treatment, with the caveat that remineralization is unpredictable on occlusal surfaces. Caution is urged when using these devices. Using a medical paradigm, surgical intervention is only indicated when there is cavitation. Devices with increased precavitation sensitivity might lead a dentist using the old surgical paradigm to early surgical intervention (restorations) where medical treatment (remineralization) is indicated.

While caries activity describes the status of the caries process as improving or worsening (remineralization or demineralization) for a tooth, caries risk is used to describe the patient. Caries risk can be defined as the likelihood that the patient will experience new cavitation. When educating patients, inform them that there are factors that increase risk and those that decrease risk. The factors that increase the likelihood of a future carious lesion are the presence and levels of specific bacteria and the level of fermentable carbohydrates (sugar). Bacteria are necessary to metabolize carbohydrate, but carbohydrate must be present. Not only are Mutans streptococci (MS) and Lactobacilli (LB) acidogenic (they produce acid), they are also aciduric, meaning they thrive in an acidic environment. Many other bacterial species cannot survive in an acidic environment. Therefore, the presence of elevated levels of sugar creates an environment in which MS and LB will thrive. Sugar consumption 2 or more times a day between meals places a person at high risk.24

The factors that lower the risk for future carious lesions are normal salivary flow and high levels of fluoride. Stimulated salivary flow below 0.7 mL/minute is considered a risk factor for caries.25 Other risk factors are past caries experience (decayed, missing, or filled [DMF] teeth or surfaces), lesion location, and medical history (diseases or medications that can lead to xerostomia, or medications containing high levels or concentrations of fermentable carbohydrates).
Three risk categories for caries have been created: low, moderate, and high (Table 1). There are a number of criteria that are used to classify patients into one of the 3 groups. Tables 2 to 4 represent one example of the traditional way of classifying caries risk. Table 1 shows a very simple treatment-oriented method of placing patients into one of 3 categories. Patients with one or more existing cavitated lesions are classified as high risk. First, the likelihood (risk) of a patient with an existing cavitation having a cavitation within a year is 100%—the cavitation is already present. A cavitation is a finding of an advanced lesion in a person with disease (caries). That finding implies high risk. Second, since all patients in this category have cavitations, all will need surgical intervention (restoration). They may or may not need remineralization treatment for other lesions.

There are 2 types of moderate-risk patients: those patients who have rough, chalky white-spot lesions, and thus are demonstrating active demineralization, and those patients who do not have rough, chalky white-spot lesions (they may have smooth, shiny white spots), but have an existing risk factor such as xerostomia or orthodontic appliances. These patients do not have a cavitated lesion, and are not currently in need of surgical treatment. Remineralization and prevention of future de-mineralization with the use of a medical approach is indicated.

Most patients will fall into the low-risk category. These individuals have no cavitated lesions and have no active lesions. They may have inactive white spots that are smooth and shiny. These patients do not need surgical or remineralization therapy. Classic preventive approaches are indicated.

**Table 1. Risk Levels.**
- **High-Risk Patient**
  - One or more cavitated lesions
  - May or may not have rough, chalky white spots
- **Moderate-Risk Patient**
  - Rough, chalky white spots
  - Moderate risk factors
- **Low-Risk Patient**

**Table 2. High-Risk Patient.**
- One or more cavitated lesions
- May have white-spot lesions (active or inactive)
- MS levels are very high
- Sugar intake is very high
- Salivary flow is low (xerostomia)
- High DMF (Hx)

**Table 3. Moderate-Risk Patient.**
- No cavitated lesions
- Some active white-spot lesions (rough/chaiky)
- MS levels elevated
- Moderate sugar intake
- Salivary flow is normal or reduced (xerostomia)
- Moderate DMF (Hx)
### Table 4. Low-Risk Patient.

- No cavitated lesions
- May have inactive white spots (smooth, shiny)
- MS levels are low
- Diet is appropriate, sugar intake is low
- Normal salivary flow
- Low DMF (Hx)
TREATMENT

In the past, with the emphasis on a surgical paradigm, treatment consisted of dental restorations. Clinicians were addressing the macroscopic conclusion of the process (cavitation) and were generally ignoring the biochemical nature of the disease. For the modern treatment of caries, a 4-step medical model is used that has as its goal arresting and reversing the caries process.

Step 1

The medical model (Table 5) first addresses the need to control the bacterial component. This involves 2 phases: restoration, then medication. In medicine, if a patient has an abscess, the area would be incised and drained, followed by use of an antimicrobial agent. With caries, debridement is accomplished with the restoration. This involves removal of a very large local microbiological burden. To treat the disease (the infection on the tooth surfaces), antimicrobial agents are required. In general, dentists continue to use a surgical approach when treating cavitated lesions. Cavitated lesions are debrided and then filled with glass ionomers, compomers, composites, or IRM (restorations containing fluoride should be used whenever possible). Although amalgam is not contraindicated, restorative materials providing sealed margins will help prevent micro-leakage. Very large lesions may require temporary crowns. Included in the surgical or mechanical aspect of bacterial control is the use of dental sealants. (Sealants are a mechanical approach; just as restorations reduce the bacterial load via a mechanical procedure, so do sealants.)

While the surgical antimicrobial treatment is being implemented, the second part of Step 1, chemotherapeutic antimicrobial treatment, is initiated. A combination of fluoride varnish, chlorhexidine (CHX) rinse, and xylitol gum is used to lower the count of MS. A 0.12% CHX rinse, 0.5 oz, administered once a day for one week each month for 6 to 12 months should be prescribed. The rinse is used during a 7-day period each month. For high-risk patients, it is important to verify that this approach has reduced the bacterial count. This can be accomplished using a bacterial culturing technique. CRT Bacteria (Ivoclar Vivadent) will detect both MS and LB.

Fluoride varnish is another antimicrobial/remineralization agent. CavityShield (the original yellow formulation) and Vanish (a new, white formulation with a more aesthetic appearance) are varnishes manufactured by OMNI Preventive Care. These varnishes contain 5% sodium fluoride (NaF; 22,600 ppm of fluoride). Initially, the varnish is applied 1 to 3 times within a 10-day period. The initial treatment is followed by one dose every 3 months for the first year.

The third part of the combination antimicrobial therapy is the use of xylitol gum. Xylitol is a 5-carbon sugar alcohol that cannot be metabolized by MS. A total daily dose of 8 g of xylitol is recommended. Sources for this gum include Epic Dental and Xlear, which offers Spry gum. The anticariogenic effect of xylitol is well-documented. Xylitol is not fermented by cariogenic plaque bacteria, and thus does not lower the pH of plaque. Because plaque pH does not decrease, enamel demineralization does not occur, and plaque bacteria do not proliferate. In fact, xylitol reduces the accumulation of plaque on the tooth surface. The use of xylitol may promote a permanent reduction in oral MS levels.

Step 2

Step 2 is focused on reduction of risk for caries. As an analogy, after treatment for a myocardial infarction, medical attention turns...
to reducing the risk factors for a future infarction. The same concept is applied to caries. First, sugar intake must be reduced. Use sucrose substitutes whenever possible. Further, attempt to increase salivary flow in the xerostomic patient. This can be approached with the use of xylitol gum, special oral rinses, and working with the patientís physician to change medications that cause the xerostomia. Finally, home fluoride use is increased. This will be discussed below.

**Step 3**

Step 3 is focused on remineralization, and applies to patients with active caries lesions. The goal is to prevent new lesions and/or reverse active lesions. There are 4 parts to this step. First, fluoride varnish is used, since remineralization has been shown to occur with the use of fluoride varnish. 34-37

Second, home fluoride is used. For the moderate-risk or high-risk patient a 5,000 ppm dentifrice (PreviDent 5000 [Colgate-Palmolive] or Control Rx [OMNI Preventive Care]) or gel (PreviDent) is used twice a day. An over-the-counter rinse containing 230 ppm can also be used several times each day. Two examples would be ACT (Johnson&Johnson) and Fluoriguard (Colgate-Palmolive). These rinses are especially useful at bedtime. For the very high-risk patient a 5,000 ppm dentifrice or gel is used once a day as a toothpaste, and a second time each day in a tray for 4 to 5 minutes. In these very high-risk patients an over-the-counter rinse containing 230 ppm is also used several times each day.

Third, the use of xylitol gum is recommended.

Fourth, a source of calcium, such as MI Paste (GC America), is recommended twice a day. The active ingredient in MI Paste is Recaldent (CPP-ACP). Casein phosphopeptide (CPP) is a milk product that is bound to amorphous calcium phosphate (ACP). ACP is more effective than calcium phosphate, as it supplies more bioavailable calcium and phosphate. The CPP protects the ACP, ensuring delivery of the calcium and phosphate to the tooth surface. The ACP is released during acidic challenges, thus allowing for an even greater bioavailability of calcium and phosphate when it is needed most. This enhances remineralization. 38-41

An alternative to MI Paste is a product containing NovaMin, such as Soothe-Rx (OMNI Preventive Care). NovaMin (calcium sodium phosphosilicate) is a bioactive glass originally developed as a bone regenerative material. This material is reactive when exposed to body fluids. This leads to sodium ions in the glass exchanging with hydrogen ions in saliva, causing the pH to rise. Calcium and phosphorus migrate from the glass to form a calcium phosphate layer. Over time this layer crystallizes into hydroxycarbonate apatite. 42

**Step 4**

Step 4 is concerned with long-term follow-up, and involves personal and professional interventions. The goal is to achieve and maintain low-risk status. The recall frequency is 3 months for high-risk patients and 6 months for low-risk patients. Moderate-risk patients are seen every 3 months if active caries lesions are detected and every 6 months if caries lesions are not detected.

At the recall visit, evaluate both caries activity and caries risk. If cavitations are found, the infection is still active. Also reassess the risk status. At this time, determine the need for additional antimicrobial or remineralization therapy. What is the level of home care? Fluoride varnish is to be applied at every recall visit for both moderate-risk and high-risk patients. Finally, in all patients encourage a reduction in the use of sugar, especially between meals.
CONCLUSION

The medical model for the prevention and treatment of dental caries has been described. By considering the risk category and caries activity state, clinicians can form a number of treatment groups. These groups will be described in Part 2 of this article.
REFERENCES


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A Modern Paradigm for Caries Management, Part 1: Diagnosis and Treatment (#86.1)

1. Dental caries can be best defined as ___.
   A) a bacterial infection caused by specific microorganisms
   B) tooth demineralization
   C) the point at which the process of bacterial demineralization of tooth structure overwhelms the patient’s ability to remineralize tooth structure
   D) cavitation of the tooth surface

2. The process of tooth demineralization in the caries disease process ____.
   A) begins as a breakdown of surface enamel
   B) is unrelated to bacteria
   C) always progresses to the pulp
   D) is the result of bacterially produced acid removing calcium and phosphate from the subsurface enamel

3. An active lesion is ____.
   A) progressing toward cavitation (demineralizing).
   B) rough to the touch of an explorer
   C) chalky in appearance
   D) all the above

4. Caries risk ____.
   A) applies only to a single tooth at a time
   B) is the likelihood that the patient will experience a new cavitation
   C) is completely unrelated to bacteria levels
   D) is completely unrelated to saliva flow

5. A patient with moderate risk for caries ____.
   A) could present with rough chalky white spots without any cavitations
   B) could present with rough, chalky white spots with cavitations
   C) could present with cavitations and without any white-spot lesions
   D) could present without any risk factors or detection of any lesions

6. Step one of the medical model ____.
   A) consists only of placement of fillings
   B) does not include sealants
   C) consists only of the use of 3 medications
D) consists of both the placement of fillings and the use of 3 medications

7. Chlorhexidine rinse is used in the medical model ____.
   A) once a day for one week each month for 6 to 12 months
   B) twice a day for 3 months straight
   C) once a week for 6 to 12 months
   D) it is not used because of the risk of tooth staining

8. The finding of a cavitation is important because _____.
   A) it is the only way to diagnose caries
   B) there is no therapy for caries other than restoration
   C) it is the only method that is available to assess the activity level of the tooth
   D) before cavitation we use only medication to treat, while after cavitation we must place a restoration in addition to using medications

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