

New Approaches to Diagnosis, Management and Treatment of Dental Caries

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Dental caries, according to the United States Surgeon General report on Oral Health in America, is one of the most common chronic diseases among five to seventeen year olds.¹ In their study, it was more common than asthma, hay fever or chronic bronchitis. Although we do not have this type of data available in Canada, one can assume that dental caries is extremely prevalent in the population. A great deal of general practitioner's time is spent treating dental caries. The dental profession understanding of caries and treatment approach has been evolving as new diagnostic devices and preventive techniques are introduced to our practices. In 2001, the National Institute of Health's (NIH) Consensus Conference on the Diagnosis and Management of Dental Caries throughout Life concluded:

"Dental caries is an infectious, communicable disease resulting in destruction of tooth structure by acid-forming bacteria found in dental plaque, an intraoral biofilm, in the presence of sugar. The infection results in the loss of tooth minerals that begins with the outer surface of the tooth and can progress through the dentin to the pulp, ultimately compromising the vitality of the tooth."²

This statement combines a number of new components from the traditional approach taught over the last twenty years in dental schools. Our patients assume that tooth decay is caused by eating sugary foods, not that dental caries is an infectious communicable disease caused by acid forming bacteria. Patients, along with us have the opportunity to look anew at how we diagnose, prevent and treat caries. The conference states that

"In order to make continued progress in eliminating this common disease, new strategies will be required to provide enhanced access for those who suffer disproportionately from the disease; to provide improved detection, risk assessment, and diagnosis; and to create improved methods to arrest or reverse the noncavitated lesion while improving surgical management of the cavitated lesion."

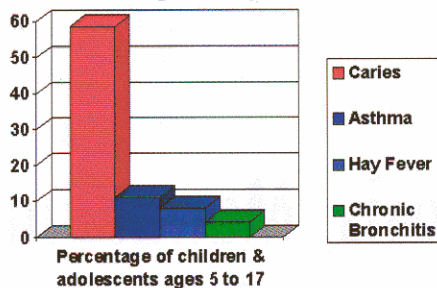
Dentistry is beginning to move from the surgical model for preventing tooth decay (placing restorations) to identification of early carious lesions and treating them with non-surgical methods including remineralization. One can place a number of restorations in a mouth, without treating the underlying disease. The bacteria remain in the plaque biofilm on

the remainder of the teeth capable of creating new areas of decalcification and cavitation. Patients are beginning to expect that we can treat this disease or at least provide them with a reason as to why they or their children continue to develop carious lesions.

Dental caries arises from an overgrowth of specific bacteria that can metabolize fermentable carbohydrates and generate acids as waste products of their metabolism. Streptococci mutans and Lactobacillus are the two principal species of bacteria involved in dental caries and are found in the plaque biofilm on the tooth surface.^{3,4,5} When these bacteria produce acids, the acids diffuse into tooth enamel, cementum or dentin and dissolve or partially dissolve the mineral from crystals below the surface of the tooth. If the mineral dissolution is not halted or reversed, the early subsurface lesion becomes a "cavity". These early subsurface lesions are not detectable with our current technology.

These bacteria along with others colonize tooth surfaces as plaque, which researchers have now come to recognize as a biofilm.⁶ A biofilm is a well-organized cooperating community of

Dental Caries is one of the most common diseases among 5 – 17 year olds



Note: Data included decayed or filled primary and or decayed filled or missing permanent teeth. Asthma, chronic bronchitis and hay fever based upon household respondent about the sampled 5 – 17 year old Source NCHS 1996

FIGURE 1

microorganisms.⁷ Previously, bacteria had been studied as they grew in colonies in Petri dishes in a laboratory. With more sophisticated techniques, researchers have been able to study bacteria in their natural states.⁸ Microorganisms in a biofilm are not evenly distributed. They are grouped in micro colonies surrounded by an enveloping intermicrobial matrix. Fluid channels move through this matrix carrying nutrients, waste products, metabolites, enzymes and oxygen. Each micro colony has its own environment with differing pH, nutrients, oxygen gradients etc. Bacteria in biofilms communicate with each other by sending out chemical signals that can trigger the release of proteins and enzymes. This type of environment may contribute to some of the resistance to anti-microbials.⁹ One of the best methods for dealing with plaque biofilm is its meticulous removal by brushing or professional cleaning.¹⁰ The use of some anti-plaque agents such as chlorhexidine, hexetidine amine fluoride/stannous fluoride, triclosan and others may inhibit biofilm development and maturation as well as affect bacterial metabolism and thus help in the prevention of caries and periodontal disease.¹¹

The tooth surface undergoes demineralization and remineral-

ization continuously, with some reversibility. When exposed to acids, the hydroxyapatite crystals dissolve to release calcium and phosphate into the solution between the crystals. These ions diffuse out of the tooth leading to the formation of the initial carious lesion. The reversal of this process is remineralization. Remineralization will occur if the acid in the plaque is buffered by saliva, allowing calcium and phosphate present primarily in saliva to flow back into the tooth and form new mineral on the partially dissolved subsurface crystal remnants.¹² The new “veneer” on the surface of the crystal is much more resistant to subsequent acid attack, especially if it is formed in the presence of sufficient fluoride. The balance between demineralization and remineralization is determined by a number of factors. Featherstone describes this as the “Caries Balance”, or the balance between protective and pathological factors¹³ (Fig. 1).

The NIH Consensus Conference on Dental Caries concluded that dental caries is an infectious communicable disease. Detectable levels of *Streptococcus mutans* occur in children’s mouths only after the eruption of the first primary tooth. The source of infection appears to be the mother or caregiver.¹⁴ A number of studies have found that

The Caries Balance

Pathological Factors

- Acidogenic Bacteria (*S. Mutans, S. Sobrinus & Lactobacilli*)
- Reduced Salivary Flow
- Frequency of fermentable carbohydrate ingestion

Protective Factors

- Saliva flow & components
- Proteins, calcium, phosphate, fluoride, immunoglobulins
- Antibacterials
- In saliva and extrinsic Fluoride, Chlorhexidine, iodine

Caries

No Caries

Adapted from Featherstone, J. D. B., JADA 2000

FIGURE 2

mothers with high concentrations of salivary *mutans streptococci* tended to have highly infected children.¹⁵ These children also had a greater risk of developing a large number of carious lesions in their primary teeth.^{16,17} Mothers with low levels of salivary *Streptococci mutans* had children with below threshold levels. Brambilla and others demonstrated that by using a mouth rinse protocol to reduce maternal *mutans streptococci* levels starting at six months of pregnancy up to delivery they were able to delay the colonization of bacteria in their children’s mouths.¹⁸ Using this evidence, we can now begin to help prevent or reduce the risk of caries in children.

One of the popular approaches to caries prevention is to develop a caries risk assessment approach for treating patients. This would involve identifying patients with an elevated series of risk factors for developing caries and providing them with more intensive preventive therapies. Risk assessment can be as simple as noting that a patient has developed one or more carious lesions within one year and then increasing recall frequency, reviewing home care etc. Understanding the “Caries Balance”, as illustrated in Fig. 1, can facilitate the development of a more sophisticated approach to caries risk assessment. The follow-

ing variables should be assessed in developing an overall assessment of caries risk:

- number of decayed missing or filled teeth,
- number of new carious lesions within the past year,
- frequency and timing of ingestion of fermentable carbohydrates,
- elevated levels of mutans streptococci and lactobacilli in saliva,
- salivary flow rate,
- lack of fluoride in the drinking water and use of fluoridated toothpastes,
- poor oral hygiene at home care,
- presence of heavy plaque on teeth,
- presence of intraoral appliances,
- presence of white spot lesions
- for infants, we need to assess these same factors in the mother and or caregiver.

If a number of these factors are present, then considering how we can help our patients can reduce their risk for dental caries.

We must first assess which of these factors are significant in increasing our patient's risk for caries. In some instances, reduced salivary flow rates (such as Sjorgen's Syndrome) may dramatically increase the caries risk. In other situations, poor oral hygiene, poor diet and lack of fluoridated tooth pastes may increase risk. There is no correct ranking in order of importance for these risks but there are a number of papers on caries risk assessment that bear further review.¹⁹⁻²¹ One of the most recent caries risk assessments were published in the Journal of the California Dental Association in 2003.²² It provides both a template for caries risk assessment and some educational tools for patients. This can provide you with a starting place for creating your own series of tools and assessments for your practice.

There are a number of preventive tools we can use. The most obvious is proper brushing using a fluoridated toothpaste. We can also:

- modify diet,
- use fluoride rinses and lozenges,
- use high concentration fluoride toothpastes or varnishes,
- use of sugar free mints especially those containing Xylitol,²³
- more frequent recall appointments,
- antibacterial mouth rinses including those containing chlorhexidine gluconate,
- for dry mouth, use of baking soda containing toothpastes or rinsing with a baking soda suspension.

These are the current set of tools that we can utilize. More tools are likely in the near future especially as technology for early detection improves. There is some discussion in the literature about the use of 10 percent povidone iodine which could be applied topically every two months to reduce the incidence of caries in high-risk children.²⁴ Antimicrobial therapy may also help to reduce Streptococci mutans levels and thus reduce caries and the risk of transmission.²⁵

In addition to developing more preventive tools, more sensitive diagnostic systems must be developed to identify early lesions before cavitation and even before the formation of a white spot lesion. The Third Indiana Conference on Early Detection of Dental Caries²⁶ provided an opportunity to examine a number of new systems for early detection of caries. There are a number of new diverse techniques for detection ranging from the use of ultrasonic waves, polarized optical coherence tomography, photothermal and laser luminescence, fibre optic confocal microscopy and infrared thermographic imaging. A number of these techniques involved the use of infrared or near infrared lasers to examine the

tooth. Most appear to be more accurate than visual or radiographic methods (our current tools) without the potential harmful side effects of dental radiographs.

Much remains to fully understand the pathogenesis of dental caries. Currently, the accuracy and validity of any caries risk assessment is only as good as the clinical and diagnostic skills of the clinician. We need to be aware, that conditions in our patient's mouths may change or their habits may change which will necessitate our need to re-evaluate their risk for developing caries. We also need to be wary about letting our patients assume that they will always be caries free or that they only need to come in for dental check ups at infrequent intervals. Dental check-ups not only involve assessing caries but also involve other factors that are important to our patient's overall oral and general health. Caries risk assessment will help you to identify those patients who need more attention and possibly more intensive preventive therapy. Patients are expecting that we can provide them with more information and more therapeutic approaches to management of carious lesions. Caries risk assessments are one of these approaches.

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Dr. Abrams is a fellow of the Pierre Fauchard Academy and the Academy of Dentistry International He was recently awarded the Barnabus Day

Award from the Ontario Dental Association for 20 years of service to the profession. He has been involved in the development of new technology for the diagnosis of caries. He jointly holds patents with Dr. Andreas Mandelis on this particular technology.

Disclosure: Dr. Abrams is a partner in the development of a laser-based device using frequency domain photothermal radiometry and luminescence. This is one of the new technologies mentioned in this article.

Oral Health welcomes this original article.

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