Caries: A clinical perspective of the oral disease we struggle to manage

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Abstract

Caries, the biofilm disease cannot be treated surgically, which is what the primary focus has been upon in the past. As a profession, we need to make a conscious effort to address the disease as well as the symptoms. We are experts at treating caries symptoms and their ongoing consequences, and now need to become as effective and efficient at managing the actual disease.

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Caries and periodontal disease are the two primary diseases that our profession has to deal with. When I look back at the past 30 years in practice, I would have to say that over the years, periodontitis has been much easier to manage and treat than has caries.
and a significantly larger proportion of my patients suffer from the ravages of caries than suffer from periodontitis. Both periodontitis and caries are basically caused by an imbalance in the bacterial populations of what are natural and normally healthy biofilms. The complexities of the disease we know as caries are the multiple factors that are associated with the evolution of a healthy bacterial biofilm population, to one that is pathological. Caries is an infectious and transmissible disease, and the primary infection can often come from family members or caregivers. Even once all these factors are understood, it is still a significant challenge for many patients to be able to modify their risk factors in order to create an oral environment that will lead to a re-establishment of a healthy bacterial population within the oral biofilm. The understanding of the behaviour and complexities of biofilms helps explain the difficulties that we often face in treating caries at the clinical level. The surgical excision of demineralized and infected tooth structure does nothing to change the primary caries infection. The pathological biofilm is still present, and unless this is addressed, the patient is going to return in a year or two with further cavities. Treating caries with a focus on risk assessment and management has been more effective than simple restoration of cavities.

A healthy biofilm can be made up of over 700 bacterial species, of which less than 1% are potentially pathogenic bacteria. A healthy biofilm acts as a first-line defence to help protect the mouth from infection by pathogenic bacteria or other pathogens. Biofilms, by their nature, are very resistant to change, and when they do change, it usually takes time for evolution of the bacterial species to occur. Modifying pressures can cause a change from constant overload of pathogenic organisms, external risk factors and risk behaviour. These can all lead to environmental changes within the biofilm, which favour the proliferation of aciduric and acidogenic pathogenic species like mutans streptococci and lactobacilli, that help them to take over the biofilm. A cariogenic biofilm may consist of over 96% acidogenic/aciduric, pathological bacteria, compared to less than 1% in a healthy biofilm. When all the factors that may contribute to a biofilm evolution are examined, it appears the primary driver is an acidic pH shift that can be either extrinsic or intrinsic to the dental biofilm, or both.

Depending on the patient’s contributing risk factors, creating a biofilm population shift from a pathological one, back to a healthy one, can take considerable time and effort. Brushing and flossing breaks up the biofilm, which is an essential factor in caries control. However, this does nothing to change the bacterial species that are present as the biofilm re-establishes itself over the next 12-24hrs and generally reflects the species that were present prior to brushing. As an analogy that I use with my patients: simply mowing a weed-filled lawn does nothing to change the proportion of weeds in the lawn; they are just a bit shorter. Equally, spraying the weeds (using a simple antibacterial mouth rinse) with a weed killer does not prevent new weeds from growing straight back again. We have to do more, like fertilizing the lawn, to help promote the growth of healthy grasses. When treating caries, this analogy means mechanical debridement, using antibacterial rinses, preferably ones that help promote the establishment of healthy bacteria, management of foods that promote the production of acid from aciduric bacteria, and the use of rinses that help challenge the acidic environment of a cariogenic biofilm.

The ideal way to help our patients prevent damage to their teeth from a caries infection would be to diagnose the presence of a pathological biofilm before it has done damage to the teeth. Our current diagnostic model relies primarily on the detection of the signs and symptoms of a caries infection. The first observable sign is a white spot lesion in the enamel, probable damage in a fissure, or early radiographic evidence of demineralization. This is the equivalent of waiting for angina to develop, and then telling the patient that they have cardiovascular disease, rather than assessing patients for risk factors associated with the development of cardiovascular disease. The ideal would be to screen patients to test their biofilm for the presence of an imbalance in the bacterial flora. This would then give us a chance to help the patient address the issues that are leading to this bacterial population shift, before damage has...
even occurred. In reality, this is no different from many screening procedures that we expect from the health care sector for helping us identify our risk for heart disease, some cancers, diabetes etc. However, this approach requires a philosophical change in how a practice is managed.

What is the reality of instigating a medical approach to diagnosing and treating a biofilm disease rather than waiting for damage to occur to the teeth? Firstly, we need a quick and effective way of clinically testing the dental biofilm for potential pathogenicity. Secondly, we need to be able to effectively educate the patient on the potential consequences of a cariogenic biofilm. Finally, we have to be able to offer patients an effective treatment and management program that they can take home with them.

A historical management pathway, still used at the moment, is to detect the symptoms of the disease (cavities), and then simply restore them. However, a patient with high risk factors, but no current clinical expression of these factors, which may also include a cariogenic biofilm, is simply a patient with a disease that is yet to express its symptoms. Patients much prefer the concept of treating the infection before it has led to the need for a tooth to be drilled. However, this is a complete reversal of the systems that are commonly in place in a practice. To successfully make a change requires planning and education of the staff.

Having recently been down this path, I found that the easiest way to change is to start with the end point in mind and work back through the plan to contemplate how to integrate this into the patient treatment flow. Not only does the dentist need to understand the concepts, but so do the staff. It is important that the staff have a good knowledge base, because the dentist will not have the time needed to educate all the patients. However, ability to make successful changes in a practice requires significant time spent on education and systems development. One of the biggest time consumers can be the education of the patients. To this end, it is essential that the staff be well trained, as they can become an additional source of information transfer.

Another very effective way of educating patients can be via a practice newsletter that is sent out as the next examination recall.

This can be used to explain a change in the practice’s philosophy, and let them know what differences to expect that will be different on their next visit. Experience has shown that this is a very effective way to get detailed information across because most patients do read their dentist’s newsletters. The more information given to patients prior to their dental visits, the less chair-time will be needed to explain caries risk assessment and its benefits to them.

This article is in no way meant to be an “advertorial” but from personal experience, I have found that changing systems, or introducing new concepts into a busy practice can be very difficult. Oral Biotech, an Oregon dental company, has developed a caries screening and treatment system (Carifree) that allows easy integration into the practice because all the normal “sticking points” in making big changes have been recognized and systematized to aid in the rapid integration of an effective caries management program into a busy practice schedule. It was the simple “plug and play, caries management in a box” concept that so attracted me to the concept. I had previously been trying to develop an effective caries management program, but was not having great success in integrating the concepts into my daily routines. There are three aspects to the Oral Biotech Carifree system. Dentist and staff education, a simple biofilm screening test, and a basic biofilm treatment program that can be modified with additional products as required, to target certain risk factors in high and extreme risk patients.

**Identifying a Pathological Biofilm**

Risk assessment requires standardized risk assessment forms, educational material that will educate patients on risk factors and protective factors and on how a disturbance of the balance can lead to development of a cariogenic biofilm. Finally, a simple screening test is needed. There are currently three ways available for assessing the cariogenicity of a biofilm.
The Vivadent CRT bacterial culture kit.

This is a 48 hr bacterial culture to measure the colony forming units of planktonic (free-floating) Mutans Streptococci (MS) and Lactobacilli (LB) in a patient’s saliva. This requires the patient to chew on wax for 5 minutes and then spitting into a cup to collect the saliva which is then flowed over the double-sided agar plate that is then incubated for 48hrs (Figure 2).

The Plaque-Check+pH test kit from GC.

This is a relatively simple 5-minute chair-side test kit that measures the change in plaque pH when it is exposed to sugar. The change in plaque pH after 5 minutes gives an indication of the potential cariogenicity of the plaque bacteria. (Fig 3) This test gives a more accurate indication of biofilm cariogenicity because it allows different areas of biofilm to be tested, whereas the CRT test is simply measuring salivary levels of planktonic MS and LB bacteria shed from the overall oral biofilm.

The Cariscreen test from Oral Biotech.

This is a simple screening test of the dental biofilm and takes less than a minute. It utilizes a completely different concept to measure the potential pathogenicity of dental plaque. Acidogenic/aciduric bacteria are able to survive in a low pH environment because of their intracellular enzymes are able to operate in a low pH. They have the unique ability to maintain a neutral intracellular pH via an efficient cell wall hydrogen ion pump mechanism that removes hydrogen ions as they diffuse from the extracellular, high pH environment, back through the cell wall.

This protective mechanism operates around the clock, maintaining a neutral intracellular pH and requires significant amounts of energy, which is derived from mitochondrial ATP. The Cariscreen test measures dental biofilm ATP levels by mixing the bacterial ATP with luciferin which then produces a quantifiable level of light. The light output (Relative Light Units) has been calibrated to known pathogenic bacterial standards. The objectiv of the test is to be able to screen a patients plaque in real time (Figure 4). If a positive result is obtained, the screening test is then confirmed using a 24hr bacterial culture for Mutans Streptococci (Figure 5). Cariscreen has a sensitivity and specificity in excess of 90% based on preliminary studies; multiple university studies are currently underway. However, simply diagnosing a cariogenic biofilm is of little significance if a practical solution cannot be offered to the patient. The treatment of a cariogenic biofilm can be very complex, owing to the multifactorial aspects of the disease and the protocols presented to patients, based on their diagnosed needs, have to be simple and practical, otherwise very few patients...
will persevere to the point where they have success.

There are several effective broad spectrum antibacterial agents, isopropyl alcohol, gluteraldehyde and sodium hypochlorite, ozone and chlorine dioxide to name a few. However, alcohol, gluteraldehyde and ozone cannot be used safely as a total mouth rinse. Sodium hypochlorite is very effective in its effects on a biofilm, in that it challenges the bacteria as well as the physical mucopolysaccharide structure of the biofilm. A further desirable attribute of a mouth rinse would be for it to have a pH greater than 7.13,14. We focus on low pH drinks and foods that help create a low pH oral environment, which can aid in the development of a cariogenic biofilm, yet we get patients to use oral rinses that have can have a significantly low pH. Some rinses are as low as pH4 and very few are above pH7. For high-risk patients, it is recommended they rinse regularly with water containing baking soda to help raise the intraoral pH, so it makes sense that an antibacterial rinse would also have this ability. The sodium hypochlorite used in the treatment phase of the Carifree system is not only strongly antibacterial and broad spectrum, it also has a pH of 10.3.

When we accept we all have to have a biofilm in our mouths, the concept of trying to permanently kill off the bacteria makes no sense. We have to be trying to work with Mother Nature, rather than fight her in an un-winnable fight. One conceivable approach would be to challenge the bacteria seriously in a pathological biofilm for a short period, and then create an environment that would be conducive to the re-establishment of a biofilm containing more non-pathogenic bacteria. This is done using several strategies. The first is the modification of patient risk factors and risk behaviours including reduction in sugar and acid exposure to reduce the frequency of acid attacks on the enamel15-17. Without risk modification, nothing else will succeed, so it is essential patients are well educated with regard to this. After following a strong antibacterial challenge for several days, the next step would be to create an oral environment with a pH above 7, which was also conducive to the proliferation of non-pathogenic bacteria. The use of Xylitol18-20, fluoride21-23, and naturally occurring antibacterial agents like polyphenols24-25 and antho-cyanadins26-27 in a rinse with a pH9 is

Figure 4. The Cariscreen test requires a swab (1) to be taken of the buccal surface of 11 and 16. The swab is then placed into the tube and the required chemicals are released by snapping the vial on the end of the swab. After agitating, the tube is placed into the light meter (2). The relative light units are displayed after 15 seconds. RLUs below 1500 are low caries risk, RLUs between 1500 and 2500 are moderate risk and RLUs greater than 2500 are patients with a high caries risk.

The basic concepts in managing a biofilm disease involve firstly, physical disruption of the biofilm mass. If this is not done, antibacterial rinses will have little or no effect on the biofilm, which develops in such a way that it can resist serious attack from antibacterial agents. Ideally, the rinse should also be able to attack the physical structure of a dental biofilm which is made up of approximately 85% extra-cellular mucopolysaccharides to help expose the bacteria to the antibacterial agent.

Figure 5. 24hr culture of Mutans streptococci (MS) from plaque gathered from the dental biofilm. This culture was done because the original Cariscreen ATP test indicated the presence of a high-risk biofilm (Fig 4). This result is typical for a high-risk patient. Unlike the CRT test, the Carifree culture tube does not have to be opened to read the results, meaning staff are not exposed to the very unpleasant odours associated with plaque cultures.
designed to do just this. In the case of high risk patients, particularly those that exhibit low resting salivary pH, a mouth spray containing fluoride, and Xylitol with a pH9 associated with CaOH, can be used on a regular basis throughout the day. The goal is to make it as easy as possible for patients to comply with our recommendation. I have yet to meet many patients who find it convenient to carry around a litre of water with sodium bicarbonate (baking soda) dissolved in it so that they can sip on it in a regular basis and many patients are on a sodium restricted diet. In high-risk patients, the addition of high fluoride toothpaste and CPP-ACP paste can further enhance the pressure on a pathological biofilm.

The use of fluoride and Chlorhexidine in a caries control regime is difficult because patients have to use the products at different times, owing to the problems associated with combining cationic and anionic agents simultaneously. As soon as a management regime becomes complicated, patient compliance diminishes. The Carifree system does not have the problems associated with the combination of various products and is essentially compatible with any other ancillary products that may be required for high- and extreme risk patients. These may include the use of Xylitol and CCP-ACP containing chewing gums, fluoride varnish, Tooth Mousse and high F dentrifice.

Case Study

When I first gained access to the Carifree treatment and maintenance rinses in Feb 2004, I used them in conjunction with the Vivadent CRT test to assess their efficacy in helping modify a cariogenic biofilm. A 14yr old female presented with 14 cavities in her posterior dentition. Some were near exposures (Figures 6,7).

Figures 6 and 7. Clinical presentation of 14year old high-risk patient. The occlusal surface of 37 was even cavitated under the operculum.

A base line CFU for MS and LB was established, using the CRT test (Figure 8). The patient was then placed on the Carifree Tx rinse bid for two weeks, followed by the maintenance rinse bid for 3 weeks. This cycle was then repeated. Her risk factors were identified via a standardized questionnaire, and she was then educated as to what she needed to do to minimize her risk.

Figure 8. Pre-treatment CRT culture indicating very high risk.

Her risk factors were relatively simple in that they were primarily poor oral hygiene and excessive exposure to sugar between meals via drinks and sweets. She was taught how to clean and floss well. Following three months on the rinse cycle and completion of three of the quadrants of dentistry, the CRT test was still “moderate” in terms of the CFU score (Figure 9).

Figure 9. CRT test three months after the commencement of treatment. Some reduction in CFUs.
This was possibly due to continual recontamination of the mouth from the cavities in the un-restored quadrant. Following completion of the restorations, the patient was placed on a final cycle of the Carifree treatment and maintenance rinses and the CFUs were then reassessed (Figure 10).

**Figure 10.** Post treatment CRT results with the CFUs indicating the patient is now at low risk.

This low risk result with a CFU score \(<10^5\) was very encouraging, indicating that she was successfully addressing her risk factors and oral hygiene. In conjunction with the Carifree rinses, her biofilm had recovered to a healthy state. She continues to maintain this state.

I have had encouraging success from using the Carifree system in helping many of my high-risk patients, who in the past have not been able to control their infection through the use of Chlorhexidine, fluoride, diet control and good oral hygiene. Since the initial introduction of the Carifree screening system and the initial Treatment and Maintenance rinses, several new products have been added, all of which target the pH selection pressure that leads to a cariogenic biofilm. These include an Oral Neutralizer Gel with an elevated pH and Xylitol, Boost, an oral spray with elevated pH and Xylitol and a gum with an elevated pH and Xylitol. These products have proven very successful in helping several of my extreme risk patients, including Sjogren’s Syndrome patients and head and neck radiation patients.

**Conclusion**

A semantics tangle in dentistry has made the discussion of caries very difficult because we use the term caries to synonymously describe a biofilm disease and cavities in teeth. Caries, the biofilm disease cannot be treated surgically, although surgical treatment has been the primary focus has been in the past. As a profession, we need to make a conscious effort to address the disease as well as the symptoms. We are experts at treating caries symptoms and their ongoing consequences, and now need to become as effective and efficient at managing the actual disease.

The challenge for practitioners today is that there remains no known, documented one-size-fits-all, formula for treating dental caries. The simple one-size-fits-all therapy may work well with a single pathogen disease model but may have only limited effectiveness with a multifactorial/multipathogenic biofilm based disease model. As our understanding of the complexities of the disease process improves, new techniques and materials are becoming available to aid in improving our ability to help our patients manage their disease, focusing on treatment strategies targeted to specific risk factors and uniquely designed for each individual patient. As caregivers, we all respond to change, and are most motivated most when this is in the best interest of the people whom we serve. Once effective caries management is in place, both the dentist and the patients both feel more comfortable with the prospect of accepting advanced restorative procedures, because there is a confidence that recurrent cavitation associated with an untreated pathological biofilm will not compromise the longevity of the restorative work. The hardest part has been making the change from a surgical model to a medical model of caries management and treatment.

**Disclosure**

I was so impressed with the ease with which I was able to introduce caries risk assessment and management into my practice using the Biotech CariFree system that I have purchased shares in the company.
Resumen

No puede tratar de manera quirúrgica la enfermedad bio-membrana, caries, la cual era en el pasado el primero foco. De profesión, necesitamos hacer un esfuerzo consciente de tratar la enfermedad lo mismo que los síntomas. Somos expertos en tratar los síntomas caries y sus consecuencias en curso, y ahora necesitamos llegar a ser iguales de efectivos y eficientes de manejar la enfermedad verdadera.

Resumo

A doença biofilme, cárie, não pode estar tratada cirurgicamente, o que estava o foco primário no passado. Na nossa profissão, precisamos fazer um esforço cônscio para dedicar-nos à doença como também aos sintomas. Somos peritos em tratar os sintomas carie, e das suas consequências em andamento, e agora necessitamos a tornar-nos igualmente eficazes e eficientes em dar cabo da doença actual.

References