



HONG KONG

# Expert Forum

Fluoride Antimicrobial Approach for Caries Prevention

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## Welcome to this review of the *Fluoride Antimicrobial Approach for Caries Prevention Expert Panel meeting*, held in Hong Kong on 11<sup>th</sup> August 2013.

The meeting, which was chaired by Prof. Denis Kinane (USA), brought together some of Hong Kong's most prominent dental and oral health experts for a day of presentations and expert panel discussion on biofilm as an underlying cause of dental caries and the use of antimicrobial agents and fluoride in the prevention of dental caries.

## Expert Panel Members



**Professor Denis F. Kinane** (Chairman)  
Dean of School of Dental Medicine, Professor of Pathology and of Periodontics, University of Pennsylvania

**Professor Lakshman Samaranayake**  
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**Dr Lau Wai Sum, Eilly**  
President of Hong Kong Society of Paediatric Dentistry  
Specialist in Paediatric Dentistry

## BIOFILM AS A ROOT CAUSE OF ORAL DISEASE

Prof. Samaranayake

There is much that is unknown about the oral microbiome, the aggregate of micro-organisms that inhabit the oral cavity. It is known, however, that the oral microbiome is highly heterogeneous and that the vast majority of oral microbiome organisms exist in the biofilm (attached) rather than in the planktonic (unattached) phase.<sup>[1,2]</sup>

Oral biofilms form via an ordered sequence of events, resulting in a structured and functionally-organised species-rich microbial community attached to tooth surfaces and encased in a self-produced extracellular polysaccharide and protein matrix. Modern molecular biological techniques have identified about 1000 different bacterial species in the dental biofilm, twice as many as can be cultured. Oral biofilm pathogenicity in the oral cavity is magnified by specific biofilm characteristics.<sup>[2]</sup>

The extracellular matrix in which biofilm bacteria are embedded is the main difference between biofilm and planktonic bacteria. It has important implications for antimicrobial treatment of the oral cavity. Biofilm bacteria are more resistant to antimicrobial agents than planktonic bacteria due to the following unique characteristics:

1. Antimicrobial agents struggle to penetrate the extracellular polysaccharide component of the matrix.
2. Enzymes destructive to antimicrobial agents are secreted by the bacterial community within the matrix.
3. The low concentration of the antimicrobial agent achieved within the matrix facilitates the development of resistant phenotypes within the bacterial community.
4. The environment (pH, temperature) within the matrix is not favourable to the mechanism of action of the antimicrobial agents.

The oral biofilm is part of the normal healthy physiology of the oral cavity but it is sensitive to environmental changes. Environmental factors, such as high nutritional levels, low pH, and low saliva flow can result in microbial numbers

growing beyond their typical ranges, facilitating the development of dental caries.<sup>[3]</sup>

*“An objective of the prevention and treatment of oral disease is to control the oral biofilm in order to restore enamel integrity and reduce dental caries”*

The microbial species make-up, or ecology, of the oral biofilm, is also sensitive to environmental factors within the oral cavity. The major species of the biofilm community are non-pathogenic but a change in key environmental factors will encourage a shift in the balance of the resident biofilm ecology, such that the proliferation of pathogenic bacterial species, which were previously minor members of the biofilm community, is promoted, resulting in a shift in the remineralisation-demineralisation balance toward demineralisation and hence the development of dental caries.<sup>[3]</sup>

Antimicrobial agents can be used to moderate increases in biofilm bacterial numbers beyond their normal range and to alter the ecological shift so that growth of non-pathogenic species is favoured while that of pathogenic species is discouraged.<sup>[4]</sup>

An objective of the prevention and treatment of oral disease is to control the oral biofilm in order to restore enamel integrity and reduce dental caries.

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## ANTIMICROBIAL AGENTS FOR BIOFILM MANAGEMENT

Prof. Denis Kinane

The multicellular strategies of the oral biofilm microbial community confer a higher level of resistance to oral mucosal defences as well as to treatment with antimicrobial agents compared with the planktonic microbial community. Indeed, antimicrobial agent concentrations effective against biofilms are substantially higher (x1000) than those effective against planktonic bacteria.<sup>[1]</sup>

Dental hygiene today is focussed on modifying the oral biofilm via brushing, flossing, and use of antimicrobial mouth rinses in the home and scaling, polishing, root planing, and treatment with antimicrobial agents and antiseptics in the dental office.

Broad-spectrum antimicrobial agents commonly used in dental hygiene include chlorhexidine, essential oils, triclosan and cetylpyridinium chloride. Of these agents, essential oils and chlorhexidine in mouth rinse have been shown to effectively penetrate the microbial biofilm in *in situ* studies.<sup>[2,3]</sup>

*“The benefit of an adjunctive antiseptic mouth rinse in controlling plaque and gingivitis has also been shown in the home-care setting”*

Mechanical debridement to disrupt the biofilm is crucial in the clinical management of interdental gingivitis, in addition to the antimicrobial effects of an antimicrobial mouth rinse.<sup>[4]</sup> The benefit of an adjunctive antiseptic mouth rinse in controlling plaque and gingivitis has also been shown in the

home-care setting.

In a 6-month study of patients with gingivitis (n=237), the addition of an essential oils-containing mouth rinse to regular brushing and flossing resulted in a statistically and clinically significant lower modified gingival index (29.9 vs 11.2% reduction; p<0.001) and plaque index (56.3 vs 9.3% reduction; p<0.001) compared with brushing and flossing alone.<sup>[5]</sup> A follow-up site-wise analysis of data from the 6-month clinical study revealed that the essential oils-containing mouth rinse was better able to reach some areas of the oral mucosa than was brushing and flossing, with a higher percentage of patients who used mouth rinse demonstrating healthy maxillary marginal and proximal gingiva.

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## FLUORIDE AND ANTIMICROBIAL APPROACH FOR CARIES PREVENTION

Prof. Edward Lo

The benefits of using topical fluoride in preventing dental caries is well established based on substantial evidence from randomised controlled clinical trials. Moreover, the magnitude of the reduction in dental caries emphasises the importance of including fluoride in toothpastes, rinses, gels and varnishes for caries prevention.<sup>[1,2]</sup>

The caries-preventive efficacy of fluoride is primarily due to its effects on the demineralisation-remineralisation equilibrium at the tooth surface. Low levels of fluoride in the fluid on the tooth surface shift the balance from demineralisation, resulting in caries, to remineralisation.<sup>[3]</sup> This is achieved by fluoride-enhanced precipitation of calcium phosphates, and the formation of fluorhydroxyapatite.<sup>[4]</sup>

Fluoride concentrates in the oral biofilm and is available to the tooth surface where acid attack may be taking place.<sup>[1]</sup> Additionally, fluoride concentrates at higher levels in incipient caries lesions than in intact enamel.<sup>[5]</sup>

Topical fluoride also has antimicrobial activity.<sup>[3]</sup> Fluoride inhibits bacterial cellular enzymes and acidifies the cytoplasm. Both processes inhibit bacterial metabolism and growth. However, the *in vivo* implications of these effects are not clear.

The mechanism of action of topical fluoride is concentration-dependent as follows.

Low fluoride concentrations (0.1 – 10 ppm):

- Reduce the rate of enamel demineralization.
- Increase the rate of enamel remineralisation.
- Inhibit microbial enzyme systems; however, this effect may not be clinically important.

High fluoride concentrations (100 – 22,600 ppm):

- Provide the driving force to penetrate the dental biofilm adjacent to the tooth surface.
- Promote longer fluoride retention in enamel, plaque and oral fluids.
- Facilitate the formation of a fluoride reservoir (CaF<sub>2</sub>-like deposits).
- Exert transient bactericidal effects.

*“According to a US National Institute of Health consensus statement on the diagnosis and management of dental caries, the data for the combination of fluoride and an antimicrobial agent is suggestive of efficacy”*

A US National Institute of Health consensus statement on diagnosis and management of dental caries states that the clinical evidence on fluoride in water and dentifrices supports its efficacy and that the evidence for the efficacy of fluoride in rinses is accumulating. It also states that the data for the combination of fluoride and an antimicrobial agent are suggestive of efficacy.<sup>[6]</sup>

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## Expert Panel Discussions

The roundtable discussions commenced against the premise of the main challenge facing the dental profession being how dentistry can be elevated to the same level of public health awareness as medicine, so that dental caries and periodontal disease prevention become a public health issue. Building the behaviour of a combination of daily brushing, flossing and rinsing may benefit public health via improved individual oral health and potentially enhanced general health.

Good habits for maintaining personal health are typically established early in life. On the basis of this premise, one of the panel members suggested that educational programmes (on optimal tooth brushing and mouth rinse use) targeting primary and secondary school children and adolescents would likely be effective in establishing effective life-long oral hygiene habits, hence facilitating high compliance and motivation throughout life and potentially improving oral health in childhood and later in life. The panellist added that, at the pre-school level, educating parents on parent-assisted brushing would also have benefits.

The panel members were in agreement that a primary regimen for caries prevention is the mechanical removal of the biofilm by brushing and flossing and use of interdental devices. One panellist stated that the additional benefits of fluoride mouth rinse can be especially beneficial in high-risk individuals. This subgroup includes those who lack the dexterity to perform effective tooth brushing or flossing, such as the elderly and people with a physical disability. The high-risk subgroup also includes those who have reduced salivary flow, which can occur after radiation therapy or with long-term use of certain types of medication.

*“Based on current evidence, the regular use of a fluoride and essential oils-containing mouth rinse (from the age of 12 years) is a reasonable approach to the control of dental caries over the long term”*

The question of the tooth brushing process was raised, specifically with regarding to not rinsing out the fluoride toothpaste completely after brushing, or rinsing with a fluoride mouth rinse, so that residual fluoride remains in the mouth. One of the panel members agreed with this approach based on evidence showing that the longer that fluoride remains in the mouth the longer its beneficial mechanism of action is in effect. The same panellist also suggested that education to change behaviour is needed for this particular step in the brushing process. Another panellist agreed that minimal rinsing after brushing and use of a fluoride-containing mouth rinse should be advocated.

Revisiting the subject of targeted educational campaigns, a panellist suggested that they should not only be directed at the general public but also at dental professionals. In recent years, implant dentistry has overshadowed caries prevention and as a result many dental professionals are not necessarily up-to-date with the latest developments in dental caries prevention. Hence, education programmes on dental caries prevention should also be developed for dental professionals.

In closing the Expert Panel discussions, the Chairman proposed that, based on current evidence, the regular use of a fluoride and essential oils-containing mouth rinse (from the age of 12 years) is a reasonable approach to the control of dental caries over the long term. This recommendation was considered appropriate by the Expert Panel members, with one panellist adding that essential oils and fluoride are a logical combination of ingredients for the control of dental caries.

### Expert Panel Conclusions

- Management of the oral microbial biofilm – both in the home and professional care – is central to the effective control of dental caries. In addition, oral hygiene educational programmes targeting primary and secondary school pupils hold the potential to improve oral health throughout life.
- Fluoride in water, toothpaste, mouth rinses, gels, and varnishes is a critical component of any caries prevention programme and its effectiveness against the oral biofilm may be increased by using it in combination with antimicrobial agents.
- Adjunctive mouth rinse use is important for dental caries control in high-risk groups, such as the elderly and those with reduced salivary flow.
- An essential oils-containing fluoride mouth rinse is a reasonable choice of daily mouth rinse (from the age of 12 years) for the long-term control of dental caries.

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