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Antimicrobial Mouthrinse in Dental Practice and Home Oral Hygiene
Smoking Cessation and Oral Health

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This article is intended as an educational resource for dental healthcare professionals. It provides an overview of the following topics: 1) infection risk and control within the dental practice environment; 2) role of antimicrobial mouthrinses in infection control and patients' oral hygiene; and 3) encouraging smoking cessation in patients who are smokers and facilitating access to smoking cessation programmes.

Infection risk in the clinic

Dental patients and dental healthcare professionals can be exposed to pathogenic micro-organisms in the dental setting, including bacteria and viruses, which can be transmitted via:[1-3]

- Direct contact with blood, oral fluids, or other biomaterials from patients.
- Indirect contact with contaminated objects or surfaces (e.g., charts, instruments, equipment).
- Contact of conjunctival, nasal, or oral mucosa with droplets generated from an infected person and propelled a short distance (e.g. by coughing, sneezing, or talking).
- Inhalation of airborne droplets that remain suspended in the air for long periods.

Aerosols, sprays, and splatter generated during routine dental procedures, especially during ultrasonic and air turbine procedures, can contain blood and saliva.[3,4] The terms aerosols, sprays, and splatter are often used interchangeably to describe droplet particles; however, they differ in terms of their size. Mist-like aerosols are typically invisible and can remain airborne for prolonged periods of time. Splatter and spray consist of larger droplet particles, which can travel further than aerosols to land on the skin and other surfaces.[3]

Dental and oral health practitioners strive to manage these generated aerosols, sprays, and splatters by using personal protective equipment, barriers, and infection control protocols. However, practitioners may not fully appreciate that the spread of potential pathogenic micro-organisms is greater than previously considered and may involve the majority of the dental operatory area (**Figure 1**).[5]

The behaviour of these droplet particulates and their associated health risks are complex,[4] but aerosols, sprays, and splatters contaminated with pathogenic micro-organisms represent a potential route for disease transmission.[3,6,7] Whether or not the spread of micro-organisms results in clinical infection depends in part on the virulence (infectivity) and dose (load) of a particular micro-organism and on the susceptibility of the host.[3,6]

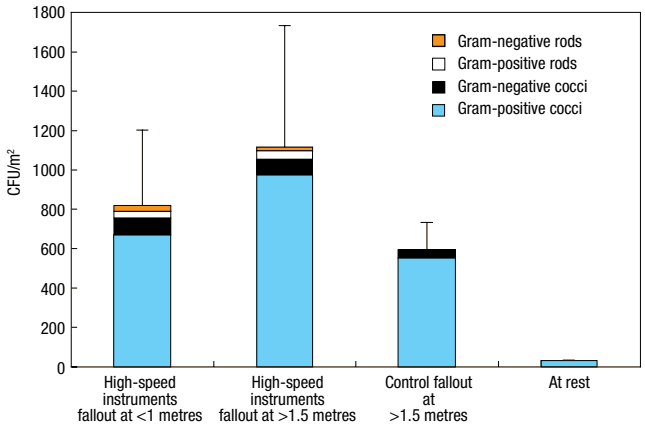

Figure 1. Mean number (with standard deviations of total counts) of colony-forming units (CFU) of different types of bacteria at various distances from treatment units after 1.5- and 3-hour collection times.[5] Significant contamination was detected at all distances sampled when high-speed instruments were used.

Infection control in the clinic

A survey of dentists in the US and seven Asian countries conducted in the early 2000s suggested that knowledge, attitudes, and the practice of infection control and safety vary greatly between countries and that there was a need for improved dental safety education and practice.[8] This finding may also be true of Japanese dentists. In a 2009 cross-sectional study, in which Japanese dentists from a single prefecture were surveyed, compliance with infection control practices was neither complete nor uniform across all precautions.[9] Dentists who had greater knowledge about universal/standard precautions had a higher level of adherence in practicing all items of infection control practices than dentists who had less knowledge. Improvements in infection control training in dentistry courses were advocated.[10]

The purpose of infection control in dental practice is to prevent the transmission of pathogenic micro-organisms between patients and between dental staff and patients. The following procedures can minimize the spread of micro-organisms in the dental clinic setting:[1,6]

- Use of personal protective equipment, including gloves, masks, and protective eyewear.
- Use of a high-volume evacuator, which exhausts externally during aerosol-creating procedures, such as ultrasonic and air turbine procedures.
- Use of a rubber dam to reduce the risk of contamination by infective aerosols (use whenever possible to isolate an area of the patient's mouth during treatment).
- Use of an antimicrobial mouthrinse by the patient prior to any intra-oral procedure, especially high-speed instrumentation – to reduce the micro-organism load in aerosols and spatter.

In addition to the routine use of personal protective equipment,[1,6] the use of pre-procedural mouthrinses, high-volume evacuation, and rubber dam are the most effective methods of minimising the risk of exposure.[4] Precautions to reduce the risk of disease transmission should be employed as standard practice because patients with bloodborne infections can be asymptomatic or unaware they are infected.[1]

Precautions for infectious patients

Given that most of the procedures used in dentistry generate aerosols, patients with active infectious diseases (e.g. influenza) who require urgent dental treatment pose a considerable infection risk to dental staff and other patients.[6] In such cases, the specific transmission-based precautions that must be followed include: scheduling these patients at the end of the day; use of pre-procedural antimicrobial mouthrinses and rubber dam; minimizing the use of aerosol-generating techniques; and applying two cycles of cleaning for environmental surfaces.

Pre-procedural mouth rinsing

The use of antimicrobial mouthrinses by patients prior to a dental procedure is intended to reduce the number of micro-organisms released from a patient in the form of aerosols or splatter that might contaminate a dental surgery and its equipment surfaces.[1] Pre-procedural rinsing may also reduce the number of micro-organisms accessing the patient's bloodstream during an invasive dental procedure.

There is no conclusive published evidence that pre-procedural mouth rinsing prevents clinical infection in dental staff or patients.[1] Nevertheless, many clinical studies have demonstrated that pre-procedural rinsing with essential oils-, chlorhexidine gluconate-, or cetylpyridinium chloride-based mouthrinses, either alone or together with use of a high-volume evacuator, is effective in reducing the microbial load of the aerosols produced during ultrasonic scaling.[11-17]

In one double-blind, randomised, cross-over study of patients undergoing ultrasonic scaling, pre-rinsing for 30 seconds with an essential oils-based mouthrinse resulted in a significant ($p<0.001$) reduction in the number of colony-forming units in recoverable aerosol samples (**Figure 2**).[15] Reduced bacterial load implies reduced risk of infection.

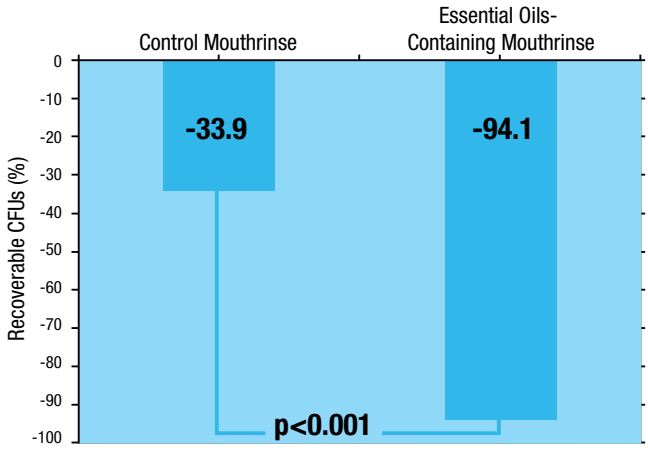

Figure 2. Percent reduction in colony-forming units (CFUs) contained in aerosols generated during 10-minute ultrasonic scaling performed after first rinsing with an essential oils-containing mouthrinse in a randomised, double-blind, cross-over study.[15]

PRACTICE TIPS 1 – INFECTION CONTROL

1. Dental healthcare professionals should be aware of the risk of disease transmission during dental procedures, especially when treating patients with active infectious diseases.
2. Aerosols and splatter generated during high-speed dental procedures are the primary means of potential disease transmission.
3. The following techniques should be employed to minimize the risk of exposure to aerosols and splatter:
   I. Use of standard personal protective equipment.
   II. Use of high-volume extraction.
   III. Use of a rubber dam.
   IV. Use of patient pre-procedural antimicrobial mouthrinse.
4. Seeing patients with active infectious disease at the end of the day.

Antimicrobial mouthrinses

The oral cavity harbours a vast variety of species of bacteria, viruses, and fungi, but it is bacteria that are the primary cause of periodontal disease.[18,19] More than 300 species of bacteria associated with periodontal disease have been isolated from the oral cavity. Periodontal disease results from the establishment of dental plaque biofilm, which involves bacteria attaching to one of several oral surfaces, including the tooth and epithelium, as well as with other bacteria already attached to these surfaces.

Mechanical removal of plaque biofilm through tooth-brushing and flossing is the gold standard for the prevention of periodontal disease and dental caries.[20] However, most people fall short of optimal oral hygiene.[21,22] Hence, the use of an antimicrobial mouthrinse is an important adjunct to professional care and tooth-brushing and flossing in the home. The most commonly used antimicrobial agents in clinical mouthrinses are: chlorhexidine gluconate, essential oils, and cetylpyridinium chloride.

Active ingredients and mechanisms of action

To varying degrees, chlorhexidine gluconate, essential oils, and cetylpyridinium chloride all disrupt the integrity of the bacterial cell membrane, leading to lysis and death (**Table 1**).[22,23] The major advantage of chlorhexidine gluconate is its ability to bind (12-hour substantivity) to soft and hard oral tissues, enabling it to act over a long period after use and to inhibit adsorption of bacteria onto oral surfaces. Cetylpyridinium chloride binds to teeth and plaque to a lesser degree than chlorhexidine gluconate and is generally less efficacious than chlorhexidine gluconate. Chlorhexidine gluconate and essential oils penetrate plaque biofilm and produce changes in microbial cell surface morphology that alter co-aggregation, colonisation, and, thus, survival.

Active Ingredient	Description	Mechanism of Action
Essential oils	Fixed combination of: Eucalyptol Menthol Methyl salicylate Thymol	Ruptures bacterial cell wall, leading to leakage of contents and cell death Penetrates the plaque biofilm to exert anti-microbial effects
Cetylpyridinium chloride	Quaternary ammonium compound	Ruptures bacterial cell wall, leading to leakage of contents and cell death May disrupt bacterial metabolic pathways, inhibiting cell growth
Chlorhexidine gluconate	Cationic bis-biguanide	Ruptures bacterial cell wall, leading to leakage of contents and cell death Binds to salivary mucins and oral surfaces, which inhibits bacterial colonization Binds to bacteria, inhibiting their adsorption onto teeth surfaces Penetrates the plaque biofilm to exert anti-microbial effects

Table 1. Descriptions and mechanisms of action of the three most-commonly used active ingredients in antimicrobial mouthrinses.[22,23]

By virtue of their various mechanisms of action, chlorhexidine gluconate, essential oils, and cetylpyridinium chloride exhibit broad spectrums of antimicrobial activity, including activity against Gram positive and Gram negative bacteria, and against a wide variety of aerobic and anaerobic bacteria.[22,24] The antimicrobial activity of essential oils is complemented by their anti-inflammatory activity, which is achieved via inhibition of prostaglandin synthetase, an enzyme involved in the formation of prostaglandin inflammatory mediators.[22]

An additional benefit of an essential oils-containing mouthrinse is that it has a neutral electrical charge and therefore does not interact with charged ions found in dentifrices, such as sodium lauryl sulphate,[22,23] Both chlorhexidine glucuronide and cetylpyridinium chloride are cationic rinses and susceptible to this interaction, which may lead to reduced biological activity. Also, unlike chlorhexidine gluconate, the essential oils are not inhibited by blood proteins, suggesting an effective user-friendly option in conjunction with mechanical brushing and interproximal cleaning.[22]

Clinical efficacy

Two systematic reviews of published evidence support the effectiveness of antimicrobial mouthrinses in reducing plaque and gingivitis when used as an adjunct to home care.[23,25] The majority of studies have shown that daily use of mouthrinses containing chlorhexidine gluconate or essential oils provide clinically significant anti-gingivitis and anti-plaque benefits compared with inactive control mouthrinse. Mouthrinse containing cetylpyridinium chloride appeared to provide more limited clinical benefits, possibly due to fewer clinical trials evaluating the same formulations of cetylpyridinium chloride. In addition to their anti-plaque and anti-gingivitis effects, the majority of antimicrobial mouthrinses have shown beneficial effects in reducing oral malodour in both short- and longer-term studies.[26,27]

In a meta-analysis of head-to-head studies that evaluated the effects of long-term (≥4 weeks) use of chlorhexidine gluconate- versus essential oils-based mouthrinses, chlorhexidine gluconate produced better results for anti-plaque benefits but was associated with considerably more staining and calculus.[28] For the long-term control of gingival inflammation, both active ingredients produced similar results. Based on these findings, the investigators concluded that an essential oils-containing mouthrinse is a reliable alternative to a chlorhexidine gluconate-containing mouthrinse where long-term anti-inflammatory oral care is deemed beneficial. Indeed, a recent meta-analysis of long-term (6-month) clinical trials supports the benefits of daily essential oils-based mouthrinse use for gingivitis and plaque control beyond that of mechanical oral hygiene alone.[29] For indications where plaque control is the main focus, chlorhexidine gluconate remains the active ingredient of first choice.[28]

PRACTICE TIPS 2 – PATIENTS' ORAL HYGIENE

1. Remind patients that mouthrinses are not a replacement for mechanical oral hygiene – rinses are an adjunct to professional and home mechanical plaque control.
2. Mechanical means, such as brushing and flossing, are the primary approaches to removing plaque at home – adjunctive use of an antimicrobial mouthrinse helps to reduce plaque build-up and gingivitis.
3. Advise patients to choose a mouthrinse with a pleasant usage experience – enjoyment using the product will increase compliance.
4. Advise patients to follow usage instructions; in particular, not to dilute mouthrinses and not to reduce the recommended rinsing time, since doing so may reduce effectiveness.
5. Advise patients not to smoke and, where possible, facilitate access to a smoking cessation programme.
6. Smoking cessation guidelines and training programmes for oral health professionals are available and should be used.

Safety and tolerability

Studies show that daily, long-term use of chlorhexidine gluconate or essential oils mouthrinses does not adversely affect oral microbial flora, including no microbial overgrowth, opportunistic infection, or development of microbial resistance.[22,23] Long-term use of chlorhexidine gluconate-, essential oils-, or cetylpyridinium chloride-containing mouthrinses does not appear to contribute to the development of soft tissue lesions or mucosal aberrations.[22] However, taste perception alteration, increased supragingival calculus formation and brown staining of the teeth and other oral surfaces is associated with the use of mouthrinses containing chlorhexidine gluconate.[22,28] In some cases the staining is severe, requiring professional prophylaxis.[30]

Regarding concerns that use of alcohol-based mouthrinses can result in desiccation of the oral mucosa, leading to xerostomia, clinical studies have shown no significant difference in salivary flow rate with alcohol-based mouthrinse.[22,23,31] Importantly, current evidence does not indicate a causal link between the use of alcohol-based mouthrinses and the risk of oral and pharyngeal cancer.[22,31,32]

Smoking and oral health

Tobacco smoking is a major factor associated with chronic periodontal disease and contributes to higher levels of tooth, attachment, and bone loss.[33-36] For example, Japanese researchers have demonstrated a positive association between smoking and periodontal pockets,[37] tooth loss,[38-40] and periodontitis.[39,40]

Pathology

The mechanisms behind the destructive effects of smoking on the periodontal tissues are not fully understood but are likely to involve interference with vascular and inflammatory processes and the negative effects of nicotine and carbon monoxide in tobacco smoke on mucosal healing.[41,42] Smoking modifies neutrophil function, which can lead to a shift to a more pathogenic oral microbiome, causes sustained peripheral vasoconstriction leading to a decrease in gingival blood flow, moderates immunoinflammatory responses, delays the healing potential of periodontal tissues, and increases the potential for bone loss.[42] Additionally, there appears to be a cumulative effect of smoking on attachment loss.[36]

Smoking cessation

The risk of periodontal disease has been estimated to be 3- to 20-fold higher in smokers than in non- or never-smokers.[33,34,43] The rate of progression of periodontal disease is increased in smokers, but reverts to that of a non-smoker following smoking cessation.[43] Indeed, there is evidence indicating that smoking cessation is an important component of periodontal treatment, and smokers should be encouraged to quit as part of their overall oral health maintenance.[44] In a large Japanese study involving men aged 40-75 years, there was no increase in the odds ratio of having >8 missing teeth and periodontitis in those who had stopped smoking for ≥11 years compared with those who had never smoked.[39]

The incidence of oral cancer, specifically squamous cell carcinoma, is four- to seven-times greater in smokers compared to non-smokers,[45] and when considering the associated increased periodontal disease morbidity and poor wound healing, smoking cessation counselling and support should form an essential role of all dental practitioners.[46]

A Cochrane review determined that, based on available clinical trial evidence, behavioural interventions for tobacco cessation conducted by oral health professionals, incorporating an oral examination component in the dental office or community setting, may increase rates of smoking cessation.[45] Of note, motivational interviewing techniques are encouraged along with nicotine replacement therapy to double the chances of long-term quitting.[46,47] UK researchers, who demonstrated that quit rates following smoking cessation advice given as part of a periodontal treatment compare favourably with national quit rates achieved in specialist smoking cessation clinics, concluded that the dental profession has a crucial role to play in smoking cessation for patients with chronic periodontitis.[48] In addition, the collaboration of Japanese dental and medical professionals in a smoking cessation programme has been shown to promote patient adherence to smoking cessation.[49]

Against this background, the American Dental Association and the Australian Dental Association advise that dental healthcare professionals should be encouraged to educate the public on the adverse health implications of smoking as well as how to quit, and that appropriate smoking cessation programmes should be integrated into dental practices.[50,51] Similar advice has been advocated by the by the Japanese Circulation Society (JCS).[52] It also emphasises the importance of dental healthcare professional-initiated education and instruction to encourage and help patients to quit smoking. However, a lack of knowledge and training may be a barrier to the provision of smoking cessation care. A survey of dental school hospital-based oral health professionals in Japan was published in 2010.[53] The survey revealed that, despite recognizing the importance of asking patients about their smoking status, the oral health professionals' delivery of smoking cessation advice and care to patients was inadequate.

Online smoking cessation guidelines for dental professionals are available (links to a selection of these are provided in the associated **Highlights box**).

Smoking Cessation Guidelines for Dental Professionals

FDI World Dental Federation (FDI) and the World Health Organization (WHO):
Tobacco or oral health: An advocacy guide for oral health professionals
http://www.who.int/oral_health/media/orh_tobacco_fdi_book.pdf

Royal Australian College of General Practitioners:
Supporting Smoking Cessation: A Guide for Health Professionals
http://www.racgp.org.au/your-practice/guidelines/smoking-cessation/

US National Institutes of Health:
Tobacco Control Monograph Series
https://cancercontrol.cancer.gov/brp/tcrb/monographs/

Japanese Circulation Society (JCS) Working Group
Guidelines for Smoking Cessation (JCS 2010)
https://www.jstage.jst.go.jp/article/circj/76/4/76_CJ-88-0021/_article

EXPERT COMMENTARY BY ATSUSHI SAITO

In Japan, oral healthcare professionals are becoming more aware of the health risks posed by aerosols and splatter during dental procedures. Effective vacuuming and the use of pre-procedural oral rinsing using mouthrinses containing essential oils, cetylpyridinium chloride, or povidone iodine may be recommended (in Japan, mouthrinses containing chlorhexidine gluconate can only be used at much lower concentration than those used in US and elsewhere). More research into this area is necessary to take an evidence-based approach to minimize the risk of infection in a practice setting.

Although the smoking rate is gradually decreasing in Japan, it is still considered to be relatively high compared with other advanced nations. Dental practitioners in Japan need to take a more active role in helping patients to stop smoking. It has been shown that Japanese dentists and dental hygienists, while perceiving that they have a role to play in smoking cessation, require training in the provision of smoking cessation care to hospital patients. To overcome potential barriers, it is necessary to provide staff with appropriate training and to create an atmosphere that supports oral healthcare professionals in promoting and engaging in smoking cessation activities.

EXPERT COMMENTARY BY SHOGO TAKASHIBA

Mouthrinse is now widely accepted and popular in Japan, especially for people whose oral healthcare is compromised, such as the elderly and cancer patients who need nursing and may have difficulty brushing their teeth, and young adults who are extremely busy and hence may neglect or rush brushing their teeth after meals.

Mouthrinse is a preferred means of maintaining oral heath by adjusting oral microflora. However, an argument remains for consideration of the components of mouthrinse because flavour and irritation are important factors for people with compromised oral health.

TAKE-HOME MESSAGES:

- **Aerosols and splatter are a potential source of cross-infection in the dental procedures.**
- **Steps should be taken to minimize the spreading of aerosols and splatter, e.g. use of high-evacuation and rubber dams.**
- **Pre-procedural use of an antimicrobial mouthrinse can reduce the micro-organism load of splatter and aerosol.**
- **As an adjunct to mechanical plaque removal, the daily use of an antimicrobial mouthrinse helps to reduce plaque formation and gingivitis.**
- **Smoking is a risk factor for periodontal disease and dental health practitioners should encourage smoking cessation and facilitate access to a smoking cessation programme, where available.**

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