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Mouthwashes: Do They Work and Should We Use Them? Part 2: Anticaries, Antihalitosis and Dry Mouth Relief Efficacy of Mouthwashes

Abstract: This article will review the anticaries, antihalitosis and dry mouth relief efficacy of mouthwashes. Fluoride mouthwashes may provide an additional benefit to toothpaste and gel in children with a high risk of dental caries, but toothpaste alone may be a more acceptable mode of delivery. There may be a beneficial effect of fluoride mouthwashes on caries levels in older adults, particularly those at higher risk of root caries. The available data of the antihalitosis effect of mouthwashes neither supports nor contra-indicates their use. The key area where a mouthwash may be of use in the treatment of patients with a dry mouth is through the anticaries effect of fluoride.

CPD/Clinical Relevance: The evidence supporting the use of anticaries, antihalitosis and dry mouth relief mouthwashes is evaluated. This provides guidance for dentists and dental care professionals of when it is appropriate to recommend the use of a mouthwash in these situations.

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The first part of this review focused on the antiplaque efficacy of mouthwashes. The second part will cover the evidence regarding mouthwashes marketed for caries prevention, the treatment of halitosis and for dry mouth relief. The final part will address the controversy surrounding the safety of alcohol-containing mouthwashes.

Caries prevention

Fluoride mouthwashes

A topical fluoride intervention

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should be effective in preventing dental caries (Figure 1), safe, easy to use and acceptable to the patient.

The evidence for using mouthwashes for caries prevention can be divided into:

- Prevention of dental caries in children and adolescents; and
- Prevention of coronal and root caries in adults.

Fluoride mouthwashes for preventing dental caries in children and adolescents

A series of seven Cochrane systematic reviews on the subject of the effectiveness of the main topical fluoride modalities (toothpaste, gels, mouthwashes and varnish) on reducing dental caries increment were conducted between 2002

and 2004.¹ Regarding the results of these reviews:

1. Evidence of the beneficial effects of fluoride mouthwash use in reducing caries levels in children was provided in a meta-analysis of 30 placebo-controlled trials.²
2. In the reviews comparing mouthwashes with a placebo, fluoride mouthwashes showed a mean caries reduction of 26% which equated to 0.56 D(M)F surfaces per year in children with high caries experience (2.14 D(M)F surfaces per year) (95% CI 22–29%)^{2,3}
3. When fluoride mouthwashes were compared to a placebo, fluoride gel, fluoride toothpaste and fluoride varnish, mouthwashes were found to be as effective as toothpaste in reducing caries levels. There was no clear evidence

that varnish was more effective than mouthwash and the comparative difference between mouthwash and gel was inconclusive.⁴

4. The benefit of using a fluoride mouthwash was present regardless of exposure to water fluoridation or other sources of fluoride exposure.³ There was a small additional benefit in using mouthwash and toothpaste compared with toothpaste alone, but the difference was not significant.⁵
5. The use of a fluoride mouthwash in addition to toothpaste was supported by the findings of another study.⁶ Participants brushed with 1450 ppm (0.145%) fluoride toothpaste for 40 seconds and then rinsed with either 225 ppm (0.0225%) or 500 ppm (0.05%) fluoride mouthwash for one minute or did not rinse. Saliva samples were collected before brushing and at seven time intervals up to 60 minutes after rinsing. Subjects did not speak, eat or drink during the 60 minutes. The authors concluded that post brushing rinsing with fluoride mouthwash improved fluoride retention in the saliva compared with not rinsing. The level of salivary fluoride was significantly higher in the group that rinsed with 500 ppm fluoride compared with the 225 ppm fluoride group.⁶
6. The authors of the Cochrane review concluded that supervised use of two strengths and frequencies of rinsing (230 ppm (0.023%) fluoride once or twice daily or 900 ppm (0.09%) fluoride weekly or once every two weeks) could lead to significant reductions in caries increment in children.² In those with low caries experience (0.25 D(M)F surfaces per year), 16 children would need to use mouthwash regularly in order to avoid one D(M)F surface. In those with high caries experience (2.14 D(M)F surfaces per year) only two children would be required to use mouthwash regularly to avoid one D(M)F surface.²
7. Little information about other outcomes was presented in the studies. For example, the percentage of children developing new caries lesions or patient-centred outcomes with regard to the acceptability of fluoride mouthwash. However, there was a high dropout rate from mouthwash studies (32%). The

authors found that patients were more likely to stay in the study if allocated to the fluoride toothpaste arm.² This indicates that toothpaste may well be a more acceptable and reliable method of delivering topical fluoride to children.

These findings had weaker support in another systematic review.⁷ The authors concluded that there was limited evidence for the caries preventive effect of daily or weekly sodium fluoride mouthwashes, compared with placebo, in permanent teeth of schoolchildren and adolescents with no other fluoride exposure. In addition, there was inconclusive evidence of an additional benefit of fluoride mouthwashes in children who were also exposed to other sources of fluoride, eg toothpastes.

A systematic review by Poulsen provided evidence on the efficacy of fluoride varnishes, mouthwashes and gels in the prevention of caries in deciduous and permanent teeth of children and adolescents.⁸ Using a similar research stream as used in the Cochrane reviews, the author found only one additional randomized controlled trial using a fluoride mouthwash, conducted in Sweden.⁹ The mouthwash contained 2000 ppm (0.2%) sodium fluoride and preventive fractions of 30–59% were found between the control and test group for four different supervised rinsing regimens. The authors concluded that supervised fluoride rinsing, in low and medium caries risk areas, on the first three and last three days of term (two terms: 12 rinses a year), was an effective way of reducing caries on approximal surfaces in 13–16 year-old children, as a supplement to oral hygiene at home and preventive treatment at dental clinics. It is important to bear in mind that, in this study, enamel as well as dentine caries lesions were included and that supervised rinsing took place because of the high concentration of fluoride in the mouthwash. Poulsen concluded that the effect of fluoride on the deciduous dentition is unknown.⁸

Recently, the American Dental Association published updated guidelines on topical fluoride for caries prevention.¹⁰ The focus of this paper was the use of professionally applied and prescription-strength home use topical fluoride products (including mouthwashes, varnishes, gels, foams and prophylaxis pastes) by those at



Figure 1. Coronal dental caries in the mixed dentition (reproduced by kind permission of Dr Elizabeth Roebuck).

high risk of caries. The recommendations were based on primary evidence and the net benefit of the intervention; in other words a balance between beneficial and harmful effects; together with the level of certainty of the evidence, that is: high, moderate and low. This grading system included the use of expert opinion where evidence was lacking, contradictory or had a high risk of bias. The recommendations only applied to the prevention of caries in patients at elevated risk of developing caries. For the use of 900 ppm (0.09%) fluoride mouthwash at least weekly in children aged 6–18 years, the evidence favoured this intervention.¹⁰

A summary of evidence of the use of fluoride mouthwashes for preventing caries in children and adolescents is presented in Table 1.

Fluoride mouthwashes for preventing coronal caries and root caries in adults

The vast majority of research which has been conducted into the effect of fluoride in preventing caries has been in children. On a population basis, caries in adults is becoming an increasingly important health issue mainly because people are keeping their teeth longer and living longer. It has also been suggested that, as adults age, they may be equally susceptible or at higher risk of coronal caries than children¹¹ (Figures 2 and 3). A series of trials came up with the following findings:

1. There is a lack of randomized controlled trials investigating the effect of fluoride mouthwashes in preventing coronal or root caries in adults.^{7,12,13}
2. The three randomized controlled trials which have been published investigated



Figure 2. Root caries (reproduced by kind permission of Dr Bill Jenkins).



Figure 3. Arrested root caries.



Figure 4. Mild dental fluorosis (reproduced by kind permission of Professor Lorna Macpherson).

the effect of rinsing with 500 ppm (0.05%) NaF once^{14,15} or twice daily¹⁶ on coronal and root caries in adults who also used a fluoride-containing toothpaste.

- In one trial a sample of 731 adults, aged between 20 and 65 years at baseline, rinsed once daily for three years with either a fluoride mouthwash or a placebo rinse. The authors found no effect of the fluoride supplement in reducing coronal caries and only a very small non-significant improvement in reducing root caries.¹⁴ There was a significant difference in the mesio-distal root caries increment, in a subgroup of participants aged over 45 years and in another subgroup of subjects who developed root caries during the course of the study, in favour of the fluoride mouthwash.¹⁴
- A trial conducted in 466 Swedish adults aged over 60 years, who completed the four-year preventive programme,

Summary of evidence of the use of fluoride mouthwashes for preventing caries in children and adolescents

- The use of a 900ppm (0.09%) fluoride mouthwash once a week is recommended in children at high risk of caries
- Mouthwashes are as effective at reducing caries levels as fluoride toothpaste
- The benefit is present regardless of exposure to water fluoridation or other sources of fluoride exposure
- Supervised mouthwash use may contribute an additional benefit to using toothpaste alone
- There is a high dropout rate from mouthwash studies which indicates that toothpaste may be more acceptable

Table 1. Summary of evidence of the use of fluoride mouthwashes for preventing caries in children and adolescents.

compared: daily rinsing with a placebo mouthwash (n = 171); twice yearly application of 12,000 ppm (1.2%) fluoride gel together with daily rinsing with a placebo mouthwash (n = 147); and daily rinsing with a 5000 ppm (0.5%) fluoride mouthwash (n = 148) on root caries increment.¹⁵ The increment in the placebo group was significantly greater than in both the gel and mouthwash groups. In addition there were significantly more reversed root caries lesions in the mouthwash group than in the other two groups.¹⁵

- Another trial in Sweden investigated the effect of fluoride supplementation, in adults over the age of 60 years at increased risk of developing root caries, over a two-year period.¹⁶ The group who rinsed twice daily with a fluoride mouthwash (n = 49) showed a lower caries increment for both coronal and root caries compared with the control group (n = 32). The difference between the groups was significant for total caries increment.¹⁶

To conclude, based on the findings of these trials it appears that the daily use of fluoride-containing mouthwashes, in older adults, may be beneficial in protecting against caries, in particular in patients at higher risk of root caries. The recent American Dental Association recommendation for the use of 900 ppm (0.09%) fluoride mouthwash, at least weekly, for the prevention of caries in adults over the age of 18 and of root caries is guided by expert opinion; evidence is lacking and the level of

certainty is low.¹⁰

Potential harmful effects of fluoride mouthwashes

There is little evidence concerning possible harmful effects of fluoride mouthwashes.³ There is weak unreliable evidence linking mild dental fluorosis (Figure 4) with the use of fluoride-containing toothpaste in children under the age of 12 months and equivocal evidence for children aged 12–24 months of age.¹⁷ It is important that future studies assessing the effectiveness of fluoride-containing products provide reliable evidence, at low risk of bias, of the risk of fluorosis and other possible harmful effects (Table 2).

New directions

The amount of fluoride ion available during and after brushing is an important factor in preventing the development of caries lesions. A new generation of toothpaste is being developed containing compounds which first release calcium ions and then fluoride ions.¹⁸ This enhances precipitation of pro-fluoride compounds, such as calcium fluoride, which act as a reservoir of fluoride ions and increase exposure over time. The same strategy may be applied to fluoride mouthwashes in the future. Including soluble calcium in a pre-rinse prior to using a fluoride-containing mouthwash has been shown to increase the amount of fluoride available in saliva by five-fold, one hour after rinsing, compared with only using the same concentration of sodium fluoride mouthwash.¹⁹ It is possible that this new

concept could result in the production of toothpastes and mouthwashes for children with lower concentrations of fluoride, which would reduce the incidence of fluorosis.¹⁸

Chlorhexidine mouthwashes

Chlorhexidine has been shown to be an effective antimicrobial against *Streptococcus mutans*. However, there is a lack of evidence that chlorhexidine is effective as an anticaries agent.²⁰ Owing to the unwanted side-effects of chlorhexidine, mouthwashes containing this product should not be recommended for prevention of caries in children or for prevention of coronal or root caries in older adults.^{21,22} There is no evidence that using chlorhexidine mouthwashes in combination with fluoride mouthwash compared with using a fluoride mouthwash alone will provide an adjunctive benefit.

Antihalitosis efficacy

Definition of halitosis

True halitosis is defined as the odour emanating from the metabolism of sulphide-producing anaerobic bacteria residing in the crypts on the posterior dorsum of the tongue.

Management of halitosis

The best way to manage a complaint of halitosis is through careful diagnosis (Table 3). Management should include advice regarding fluid intake and diet (Table 4).

Tongue cleaning

It has been suggested that daily cleaning of the dorsum of the tongue with a toothbrush is an effective way of controlling halitosis. However, a Cochrane systematic review found that use of either tongue scrapers (Figure 5) or toothbrushes for tongue cleaning was very short-lived.²³ There was only weak unreliable evidence that tongue scrapers are more effective than toothbrushes in controlling halitosis in adults and there was some limited evidence of tongue trauma using one type of tongue scraper.²³

Antihalitosis mouthwashes

The rationale for using a mouthwash is that it either neutralizes

or masks the odour emanating from the mouth. Neutralizing agents include chlorhexidine, cetylpyridium chloride, phenol, triclosan, chlorine dioxide, alcohol and metal ions, most commonly zinc. Odour-masking agents include the essential oils which temporarily disguise halitosis.

A Cochrane systematic review investigated the effects of mouthwashes in controlling halitosis.²⁴ Primary outcomes were patients' complaint of oral malodour and organoleptic measures (sniff test). Secondary outcomes were measurement using a halimeter, portable sulphide monitor or by gas chromatography together with flame-photometric detection. Organoleptic measurement, by trained breath assessors, is considered to be the gold standard for recording halitosis and has the most relevance to patients. The other methods do not measure all the possible gases arising from the tongue dorsum or are not practical for use in a clinical setting.

Five randomized controlled trials were included in the Cochrane review, involving 293 subjects, comparing antimicrobial with placebo mouthwashes or against each other.²⁴ Only studies which had recruited adults over the age of 18 years, who did not wear dentures, and excluded sources of oral malodour other than the dorsum of the tongue, were included. Because of the wide heterogeneity between the trials it was not possible to carry out a meta-analysis of the data and only a descriptive summary was reported. Some of the studies included subjects with low organoleptic and halimeter scores as well as those with higher scores. No periodontal data were presented to exclude gingivitis or periodontitis, which are common sources of halitosis. Two of the trials only used halimeter assessments. The authors concluded that mouthwashes containing chlorhexidine or cetyl pyridium chloride may be effective in reducing the numbers of odour-producing bacteria on the tongue; and chlorine dioxide- and zinc-containing mouthwashes may be able to neutralize the odour from volatile sulphur compounds. However, considering the weaknesses in study design reported above and the finding that only two of the trials were supported by government

Potential harmful effects of fluoride mouthwashes

- Dental fluorosis in children
- Possible allergies
- Staining of oral tissues
- Acute toxicity

Table 2. Potential harmful effects of fluoride mouthwashes.

Diagnosis of halitosis

- Exclude smoking and diet
- Treat caries, gingivitis, periodontitis
- Treat any mucosal sources of infection
- Exclude psychosomatic and extra-oral causes or refer for investigation and treatment

Table 3. Diagnosis of halitosis.

Management of halitosis

- Sufficient fluid intake
- Avoidance of garlic and spicy foods
- Avoidance of excessive alcoholic beverages
- Regular meals

Table 4. Management of halitosis.



Figure 5. Tongue scrapers.

or scientific funding, with the other three being industry funded, the findings have to be treated with caution.

A recent systematic review investigated the effect of tongue cleaning, toothpaste, mouthwash or any combination in addition to toothbrushing, used for a minimum of two weeks,

Common causes of xerostomia

- Medication eg anti-hypertensives, diuretics, anti-depressants
- Polypharmacy
- Anxiety or depression
- Undiagnosed or poorly controlled diabetes
- Autoimmune disease (Sjögren's syndrome)
- Radiotherapy for head and neck cancer

Table 5. Common causes of xerostomia.

compared with toothbrushing alone, in reducing measures of halitosis. The authors reported that the evidence was very weak to support their use. The most evidence available was for mouthwashes containing chlorhexidine + cetylpyridinium chloride + zinc and zinc chloride + cetylpyridinium chloride but it was weak.²⁵

To conclude, there may be a role for the use of antihalitosis mouthwashes but the available data reported in the scientific literature neither supports nor contra-indicates their use.

Dry mouth relief

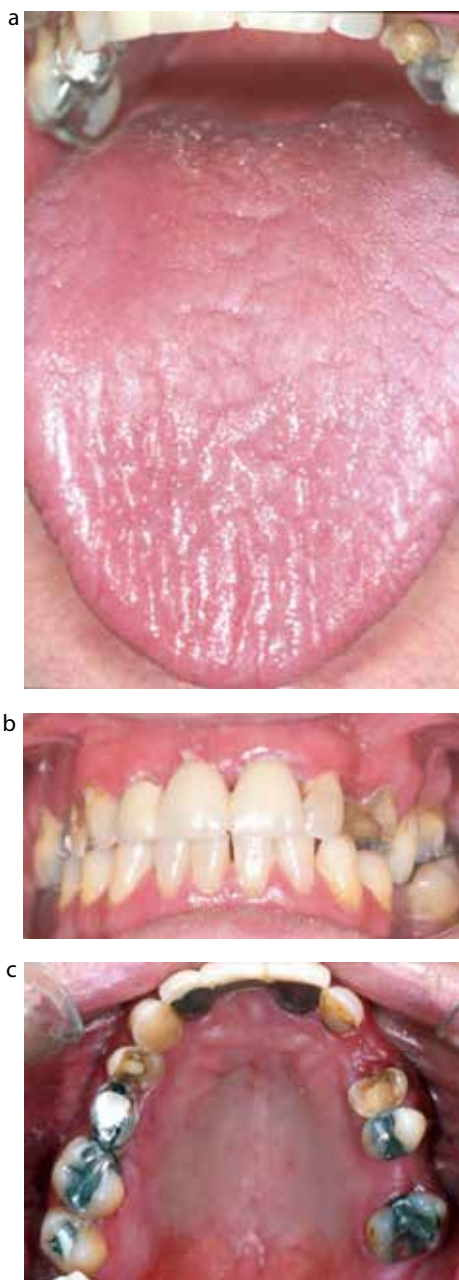
Dry mouth and disorders of salivation have been reviewed by Felix *et al* in *Dental Update* and therefore the aim of this section is to provide only a brief summary to put the use of mouthwashes for the treatment of dry mouth into context.²⁶

Causes of xerostomia

Xerostomia (the sensation of having a dry mouth) is an ever increasing problem. It is estimated that the prevalence of xerostomia in the general population is around 20% but this is higher in women (30%) and in elderly people (50%).²⁷ The main causes of xerostomia are summarized in Table 5.

Complications of xerostomia

Both subjective and objective dry mouth can have profound clinical and psychological effects for patients²⁸ (Figure 6). These are summarized in Table 6.

**Figure 6.** (a–c) Dry mouth.**Management of xerostomia**

Management of xerostomia can be divided into four areas (Table 7).

Management of the underlying condition

For some patients with a complaint of xerostomia it may be possible to treat the underlying condition, alter medication or carry out risk factor intervention and thereby improve the dry mouth sensation.

Complications of xerostomia

- Difficulty eating and swallowing
- Alterations in taste sensations
- Difficulty speaking
- Problems with denture retention
- Disturbed sleep
- Oral mucosal infection (candidosis)
- Cheilitis
- Halitosis
- Increased dental plaque and periodontal disease
- Increased coronal and root surface caries
- Sialadenitis
- Inadequate nutrition
- Depression

Table 6. Complications of xerostomia.**Systemic medication**

There are systemic drugs available which stimulate saliva production and can reduce xerostomia in different patient groups and these are the subject of two Cochrane systematic reviews.^{29,30}

Acupuncture and electrostimulation

A systematic review of non-pharmacological treatments to stimulate salivary flow found poor quality evidence that acupuncture was no different from placebo acupuncture in improving symptoms of dry mouth.³¹ The authors stated that this could have been because of the low number of participants in the two trials which were eligible to be included, because dry mouth was an outcome. This is the most important outcome since it has been shown that increase in salivary flow may not improve symptoms of dry mouth. Another possible reason that no differences were found between acupuncture and placebo acupuncture was because of the placebo effect.³¹

There was no evidence either to support or refute the benefit of electrostimulation in increasing salivary flow in patients with Sjögren's disease.³¹

Topical treatment

For many patients with incurable chronic diseases, alterations in drug therapy are not possible and therefore management of xerostomia must mainly be through

Management of xerostomia

- Management of the underlying condition
- Systemic medication
- Acupuncture and electrostimulation
- Topical treatment

Table 7. Management of xerostomia.

symptomatic relief. It is recommended that patients should be encouraged to suck ice cubes and take frequent sips of cold water, together with reducing exposure to smoking, alcohol (including in mouthwashes), sugary foodstuffs and drinks, caffeine and hot spicy and salty food.²⁷

Topical treatments can be divided into saliva substitutes and saliva stimulants. The saliva substitutes include sprays, gels, oils, mouthwashes and pastilles. Saliva stimulants include lozenges, sugar-free chewing gums and toothpastes.

Mouthwashes

A Cochrane systematic review aimed to find effective topical therapies for the treatment of xerostomia and included studies investigating both topical saliva substitutes and stimulants.²⁷ Thirty-six randomized controlled trials were included comparing topical treatments with either a placebo or another treatment. Any cause of dry mouth symptoms was acceptable. Trials of therapies tested on healthy subjects with reduced salivary flow, but no complaint of dry mouth, were excluded. It was concluded that there was weak evidence that any particular topical treatment was effective for improving xerostomia. There was only one included study at low risk and 17 studies at high risk of bias. The remainder was considered at unclear risk of bias. Many of the trials had small sample sizes and had too few participants to demonstrate a statistically significant difference between the interventions, or the test and control groups, if one had been present.²⁷

Mouthwashes for the treatment of a dry mouth fall into the category of saliva substitutes. An effective saliva substitute should be pH neutral and contain the corresponding balance of electrolytes present in natural saliva. Various mouthwash formulations are marketed for the treatment of xerostomia including linseed oil (*Salinum*)[®]

and *Oasis*[®] (glycerin, sorbitol, castor oil, cellulose gum, xanthan gum). The evidence supporting the use of these products is very weak.²⁷ Integrated mouthcare systems, of which mouthwashes form a part, may have some benefit, but larger randomized controlled trials are required to confirm this. The systems which include mouthwashes are *BioXtra*[®] (colostrum extract containing lactoferrin, lysozyme and xylitol), *Biotène Oralbalance*[®] (lysosyme, lactoferrin, lactoperoxidase and glucose oxidase in a gel base) and *Xerostom*[®] (betaine, olive oil, fluoride, calcium, xylitol, vitamins E and B5, allantoin, potassium). Five trials comparing mouthcare systems against usual care or an alternative system were included in the systematic review.²⁷ The authors stated that all of the mouthcare systems and the placebos showed some effects on the symptoms of dry mouth; but because of the wide heterogeneity between the studies there was insufficient evidence to determine whether one particular system was more or less effective than another, or the placebo, in reducing xerostomia. The British National Formulary does not include any mouthwash for prescription for xerostomia but favours gels and sprays for the relief of dry mouth.

To conclude, it appears that there is very little evidence regarding whether mouthwashes provide relief in the treatment of xerostomia or not. Having said this the evidence for the effectiveness of any particular topical treatment is lacking. It is important to manage patients' expectations in this regard. The key area where a mouthwash may be useful in the care of patients with a dry mouth is through the anticaries effect of fluoride (see above).

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