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Effectiveness of Mouthwashes in Managing Oral Diseases and Conditions: Do They Have a Role?

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ABSTRACT

Antimicrobial mouthwashes are considered to reduce dental plaque biofilm and thus the potential to prevent plaque-induced oral diseases, particularly periodontal diseases. The effectiveness of mouthwashes relates to this antiplaque role, as well as, their tooth-whitening potential and ability to mask/mange malodour (halitosis). There is also a growing interest in the use of mouthwashes as an adjunctive measure in post surgical and post-dental care, while the COVID-19 pandemic has given a new lease of life to mouthwashes as an oral antispetic that may be useful in reducing the oral viral load. The mode of action of mouthwashes varies, depending on their active ingredients, concentrations, and mode and frequency of use, as does their potential effectiveness. This article aims to provide a narrative overview of the evidence of the effectiveness of the most widely used mouthwashes in managing oral diseases, oral conditions, and adjunctive care roles.

Background

Antimicrobial mouthwashes purport to reduce dental plaque biofilm and thus carry the potential of mitigating in particular the two major plaque-induced oral diseases, caries and periodontal disease. The effectiveness of mouthwashes relates to this antiplaque role, as well as, their tooth-whitening potential and ability to mask/mange malodour (halitosis). There is a growing interest in the use of mouthwashes as an adjunctive measure to care postsurgery and post–dental treatment, and there is a resurgence of interest in the use of preprocedural mouthwashes, particularly since the onset of COVID-19. The mode of action of mouthwashes varies, depending on their active ingredients, concentrations, and mode and frequency of use; as does their potential effectiveness. This article aims to provide a narrative overview of the evidence of the effectiveness of the most widely used mouthwashes in managing oral diseases, oral conditions, and adjunctive care roles. In particular we describe in detail the following six different mouthwashes containing chlorhexidine, fluoride, essential oils, cetylperidinium chloride, povidone iodine and hydrogen peroxide as main ingredients.

Chlorhexidine

Chlorhexidine glucoronate (CHX) is one of the most frequently evaluated mouthwashes. Findings from a 2017 Cochrane review found "high–certainty evidence" of a large reduction in dental plaque with the daily use of chlorhexidine mouthwash as an adjunct to mechanical oral hygiene procedures for 4 to 6 weeks, compared to no mouthwash, placebo mouthwash, or control mouthwash (SMD −1.45; 95% CI, −1.00 to −1.90 from an analyses of 12 clinical trials of 950 participants).[1] Fewer studies of long-term use have been conducted, but findings suggest that the adjunctive use of chlorohexidine daily over 6 months results in similar "high–certainty evidence" of a large reduction in dental plaque compared to placebo/control mouthwash (SMD −1.59; 95% CI, −1.29 to −1.89 from an analyses of 9 trials of 1933 participants). There is "high-certainty evidence" that chlorhexidine reduces gingivitis in individuals with mild gingival inflammation. Evidence from the (same) Cochrane systematic review demonstrated that following 4 to 6 weeks of

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chlorhexidine mouthwash use, there was a mean reduction in gingival index scores (on a 0-to-3 scale) of 0.21 (95% CI, 0.11 to 0.31) compared to placebo/control mouthwash or no mouthwash (based on analyses of 10 trials of 805 participants).[1] This effect was maintained at 6 months, with a mean difference in Gingival Index scores of 0.20 (95% CI, 0.11 to 0.30) for chlorhexidine mouthwash compared to placebo/control mouthwash or no mouthwash (based on analyses of 13 trials of 2616 participants). Chlorhexidine has been advocated as an anticaries agent given its effective in reduction *Streptococcus mutans* levels during and after use, although there is a clear need for higher-quality studies of longer duration in order to assess whether the results translate into less development of dental caries.[2] A 2019 Cochrane review concluded that chlorhexidine mouthwash may play a role in reducing the levels of halitosis-producing bacteria, albeit it found "very low certainty evidence," given the quality and quantity of studies.[3] Chlorhexidine also has potential role as an adjunct measure of care to promote healing. A 2023 systematic review of the adjunct use of mouthwashes on gingival health after surgical procedures found evidence of better "healing" compared with a negative control.[4] Amongst the 13 studies that informed the review, most related to use of chlorhexidine mouthwashes (n = 8) of various concentrations. Overall, there was uncertain risk of bias in most clinical trials included in the review, thus precluding definitive conclusions. A 2022 Cochrane review reported that there is "moderate certainty evidence" that chlorhexidine mouthwashes (0.12% and 0.2% concentrations), used pre- and postextraction, reduce the risk of dry socket development (odds ratio 0.38 (95% CI, 0.25 to 0.58) when compared with a placebo mouthwash.[5] CHX also has a potential role in other settings. A 2020 Cochrane systematic review that CHX probably ("evidence of low certainly") reduced the incidence of critically ill patients experiencing ventilator-associated pneumonia, from 26% to 18%.[6] There has been renewed interest in preprocedural mouthwashes, particularly since the onset of COVID-19. A Cochrane review found a lack of completed studies to inform whether mouthwashes administered to patients with suspected or confirmed COVID-19 improved patient outcomes and protected health care workers treating them.[7] However, in time, with the increased focus of study, chlorhexidine's role and indeed other mouthwashes' role will be confirmed for dentistry and other settings.

Fluoride

Fluoride-containing mouthwashes have long been advocated for oral health and in particular for their role in preventing dental caries. Sodium fluoride is the most commonly used fluoride agent in mouthwashes. The concentration of fluoride in parts per million (PPM) in mouthwashes varies; the amount of fluoride in over-the-counter (OTC) mouthwashes typically ranges from ~200 to 1000 PPM, and in prescription-strength fluoride-mouthwashes they can have concentrations of fluoride of several thousand PPM. In general, OTC fluoride-containing mouthwashes are for daily use, and prescription-strength fluoride-containing mouthwashes are for use less frequently. Whilst it is acknowledged that fluoride has an antiplaque role, there is limited available specific evidence on the effectives of fluoride mouthwashes on dental plaque levels and likewise a lack of evidence on its effectiveness relating to gingivitis/periodontal diseases.[8]

In terms of dental caries, a 2016 Cochrane review of 37 trials involving 15,813 children and adolescents found that fluoride-containing mouthwashes were associated with a large reduction in caries increments in permanent teeth; this was interpreted as "moderate quality of evidence."[9] The pooled decayed, missiing and filled tooth surfaces due to caries preventive fraction (PF) from 35 trials (15,305 participants) was 27% (95% CI, 23% to 30%; I^2 = 42%). The pooled D(M)FT PF from 13 trials was 23% (95% CI, 18% to 29%; I^2 = 54%). Evidence of the effectiveness of fluoride-containing mouthwashes on preventing and arresting coronal caries amongst adults is less readily available, and in particular there is a lack of evidence with respect to its effectiveness on root caries.[10] On other aspects, there is a dearth of studies to inform the debate as to their potential role.

Essential oils

There are a range of essential oil mouthwashes containing active ingredients such as eucalyptol, menthol, and thymol, amongst others, and they go by various trade names. Their effectiveness relates primarily to their antimicrobial and anti-inflammatory properties. A systematic review evaluating the efficacy of essential oil mouthwashes reported that they are superior to placebo and mechanical plaque control (MPC) for reduction of plaque and gingival inflammation in patients with gingivitis.[11]

Reductions in plaque and gingivitis were, respectively, 32% and 24% greater for essential oils plus MPC than placebo plus MPC. The weighted mean difference (WMD) was lower for essential oils plus MPC than for placebo plus MP: Quigley-Hein Plaque Index (QHI) was −0.86; 95% CI, −1.05 to −0.66; Modified Gingival Index (MGI) was −0.52; 95% CI, −0.67 to −0.37). High heterogeneity amongst studies was apparent in terms of study designs, supervision of mouthwashes, provision of oral hygiene instruction, and profile of participants. In terms of the effectiveness of essential oils against dental caries, a systematic review claimed that most of the knowledge in the literature is based on in vitro studies assessing the effects of essential oils on caries-related streptococci (mainly *Streptococcus mutans*) and lactobacilli and that there are a limited number of in vivo clinical trials.[12] A narrative review suggests there is considerable evidence that essential oil mouthwashes are effective in prevention and management of halitosis, although only a few clinical studies have investigated this.[13] Essential oils have also been suggested to have antiviral properties, underlying a potential role as preprocedural mouthwashes.[14]

Cetylpyridinium chloride

A 2021 systematic review claimed that cetylpyridinium chloride (CPC) was effective both in plaque and gingival inflammatory control at interproximal sites.[15] A meta-analyses of 8 studies that used CPC mouthwashes reported that there was a significantly greater reduction in the plaque index score (MD; 95% CI, −0.70; −0.83 to −0.57) compared to placebo groups. Similarly, at interproximal sites, there was a

significant reduction in gingival index scores (MD; 95% CI, −0.38; −0.47 to −0.28) when using CPC mouthwashes compared to placebo. Of note in both analyses, high heterogeneity was evident (I^2 = 89% and I^2 = 98%, respectively). A previous (2008) systematic review has suggested that CPC-containing mouth rinses, when used as adjuncts to either supervised or unsupervised oral hygiene, provide a small but significant additional benefit in reducing plaque accumulation and gingival inflammation.[16] CPC-containing mouthwashes do appear to have antimicrobial activity with implications for caries prevention.[17] However, evidence specific to CPC effectiveness in preventing dental caries in vivo is lacking to confirm its role. CPC is known to inhibit production of volatile sulphur compounds and thus its potential role in management of halitosis, but limited evidence from clinical trials exists.[18] CPC-containing mouthwashes have been suggested to have potential for use preprocedurally given their effectiveness in reducing SARS-CoV-2 viral loads, although limited studies and evidence preclude consensus surrounding the role of CPC-containing mouthwashes.[19]

Povidone-iodine

Povidone-iodine (PVP-I) is a broad-spectrum antiseptic that has long been used in wound care and surgical settings. It has potential effectiveness against a wide range of microorganisms, including bacteria, viruses, fungi, and protozoa. PVP-I–containing mouthwashes have also been developed and their role for oral health considered. A 2010 systematic review claimed "a small" additional beneficial adjunctive effect with use of PVP-I in nonsurgical periodontal therapy in terms of enhanced probing pocket depth reductions (0.28 mm; 95% CI, 0.08 to 0.48).[20] Potential of PVP-I–containing mouthwashes in disinfecting cariogenic bacterial and biofilms has been observed, although there are a lack of clinical studies.[21] A systematic review claimed evidence in support of PVP-I–containing mouthwashes for prevention of chemotherapy-induced oral mucositis, although findings were from a single randomised controlled trial.[22] A 2016 Cochrane review found "very weak evidence" that PVP-I–containing mouthwash was more effective than saline/placebo at preventing ventilator-associated pneumonia amongst critically ill patients (RR, 0.69; 95% CI, 0.50 to 0.95; 3 studies, 356 participants, high risk of bias, I^2 = 74%).[23] A 2022 systematic review provides evidence of the effectiveness of PVP-I mouthwashes on reducing the number of negative reverse-transcription polymerase chain reactions in patients with COVID-19, although additional studies with adequate randomisation to enhance the evidence base are called for.[24]

Hydrogen peroxide

Hydrogen peroxide (H_2O_2) is a typical "active" ingredient of tooth-whitening agents, with a solvent base of water or water with ethanol and excipients including buffers, surfactants, and flavours. Hydrogen peroxide at concentrations of 10% carbamide peroxide (equivalent to 3% hydrogen peroxide) is being used for home and chairside teeth-whitening. However, hydrogen peroxide may be also used in mouthwashes to whiten teeth using the same mechanism. Due to concerns with chemical irritation of oral tissues, however, concentrations of hydrogen peroxide are lower in mouthwashes, typically 1.5% w/vol or less.[25] For the most part, the effectiveness of hydrogen peroxide–containing mouthwash on tooth-whitening has been based on evidence from laboratory studies, for example, colour change effects on bovine teeth with extrinsic stains.[26] A 2018 Cochrane review identified one clinical study with 78 participants who used a 1.5% hydrogen peroxide mouth rinse and found only "weak evidence" that this improved the shade of their teeth compared to placebo.[27] A 2011 systematic review concluded that hydrogen peroxide–containing mouthwashes do not consistently prevent plaque accumulation when used as short-term monotherapy.[28] With respect to periodontal health, one study from the same systematic review claimed that hydrogen peroxide–containing mouthwash used as a long-term adjunct to daily oral hygiene may reduce gingival redness. Hydrogen peroxide has been suggested to have anticarcinogenic effects and potentially enhance remineralisation, but overall there is a dearth of clinical studies supporting the effectiveness of hydrogen peroxide–containing mouthwash. There is some evidence for the potential of hydrogen peroxide–containing mouthwashes in the management of halitosis.[29] A 2020 systematic review found a lack of studies relating to hydrogen peroxide –containing mouthwash's virucidal effects.[30] However, as with other mouthwashes, those containing hydrogen peroxide have been suggested as a potential type of mitigation against SARS-CoV-2 infection.

Concluding comments and other considerations

In summary, irrespective of the mouthwash used, there appears to be strong evidence of their effectiveness in reducing plaque, and this is an important consideration given that most oral diseases are plaque-related. At present, most evidence underpins the use of chlorhexidine. In particular, there is also considerable evidence regarding the effectiveness of mouthwashes as an adjunct to conventional oral hygiene regimens for preventing and improving gingival health. Given the role of mouthwashes in gingivitis, it is assumed they have a role in preventing periodontitis and improving periodontal health, but evidence of their role and their effectiveness at this stage of gum disease is less readily available in terms of the quantity and quality of evidence. With respect to their effectiveness for preventing dental caries, aside from fluoride-containing mouthwashes, evidence for the most part relates to the effects of mouthwashes on cariogenic plaque in vitro, rather than dental caries status in vivo, and thus more high-quality mouthwash studies are required involving caries in the human host.

For fluoride-containing mouthwashes, there is moderate quality evidence for their effectiveness with adjunct use to prevent coronal caries amongst children and adolescents. Less evidence also exists, in terms of quality and quality, for the effectiveness of mouthwashes in preventing root caries and in adults. This is important to consider, given the differences that exist, in terms of risk factors and progression of root caries compared to coronal caries as well as the growing challenge of root caries in ageing populations who are retaining more and more natural teeth.

In terms of managing halitosis, again it appears that mouthwashes can play a role in masking or managing the halitosis, although managing the underlying cause of the halitosis through means of nonsurgical periodontal care is key to success. Mouthwashes may play a role in tooth-whitening, and specifically peroxide-containing mouthwashes, but studies are limited and evidence for the most part relates to in vitro studies. Such laboratory-based studies may not consider dilution effects and inactivation by saliva and thereby overestimate the effects compared to clinical bleaching. Inherent limitations of using whitening mouthwashes include short contact time with the teeth and that low pH mouthwashes potentially "soften" enamel and lead to increased tooth wear, especially if used prebrushing.

Other areas to consider the effective use of mouthwashes include healing postsurgery, chemotherapy-induced mucositis, and management of alveolar osteitis (dry socket). To date, evidence is limited in quantity and quality for use in these areas, but it is promising for the future if mouthwashes are used as part of an adjunctive management approach to oral health care. It remains to be seen, amongst the many agents described, which mouthwash would be "most effective," and this is not addressed here. There has also been a tsunami of interest in the antiviral properties of mouthwashes since the onset of the COVID-19 global pandemic, and this continues to be of great interest, with more in vivo research required.

Overall, for the most part, the evidence of the effectiveness of mouthwashes is based on literature relating to widely available commercial OTC products, these being the products more widely studied. The more widely studied the products, the more widely available the literature to confirm or refute their effectiveness. Thus, this review focused on the active ingredients of more commonly available OTC mouthwashes globally. It is acknowledged that there is evidence from other less commonly used mouthwashes, and promising evidence too, but it is beyond the scope of this narrative review to include, and thus this will be addressed in another article.

There is strong evidence that many OTC mouthwashes appear to be effective as adjuncts in some areas of oral health care, but evidence for mouthwash effectiveness is continuing to emerge in many areas, with implications in perioperative oral care in the dental setting and beyond.

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Author contributions

CM: overall review responsibility. JC: evidence-based review. AMG: evidence-based review. LW: review and comments. FW: section on hospital and respiratory.

Conflict of interest

None disclosed.

Supplementary materials

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