Improving periodontal outcomes: merging clinical and behavioral science

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The focus of this volume of Periodontology 2000 is the conservative treatment and management of mild-to-moderate forms of periodontal diseases by general dentists and dental hygienists. New data indicate that periodontal diseases are much more prevalent than previously thought, which means that there are large numbers of patients who will need to be diagnosed and treated for periodontal disease in a general dental practice (36). Conservative approaches to nonsurgical treatment include in-office therapies, such as scaling and root planing and local delivery of antimicrobials/antibiotics, followed by daily (at-home) oral hygiene procedures to remove plaque biofilm. Although it is generally considered essential for patients to utilize toothbrushing and interdental cleaning procedures on a daily basis to minimize the deleterious effects of plaque biofilm, the challenge of ‘convincing’ patients to adhere to a regimen is often difficult. The purpose of this paper is to discuss common oral hygiene procedures and products frequently recommended by dentists and dental hygienists for the treatment of mild-to-moderate periodontitis. The second part of the paper will be devoted to providing the clinician with the most useful and evidence-based information on the topic of patient motivation and adherence.

Plaque biofilm reduction

Scaling and root planing is considered the gold standard for removing plaque biofilm and calculus deposits (22, 84). Removal can be accomplished by using hand instruments or ultrasonic devices. Although power-driven scalers remove calculus at a faster rate (70), both methods are beneficial for biofilm and calculus removal, and the final end point is similar (54, 100, 105). Clinicians should always strive to remove as much of the hard and soft deposits from the supragingival and subgingival areas as possible. However, as pocket depth increases, the ability of the clinician to remove deposits with success decreases (77, 94, 104). Rarely are all deposits removed by the clinician, and biofilm reformation begins shortly after thorough scaling and root planing (33, 85). However, it is generally accepted that periodontal pocket depth and clinical attachment level can be improved with supragingival debridement, coupled with at-home plaque control and routine professional visits (33).

Consistent oral hygiene procedures performed by patients between appointments are essential for gingival health (8). Traditional instructions to patients have included brushing twice daily, performing interdental cleaning once daily and visiting the dental office twice a year. However, there is little evidence for the traditional 6-month recall intervals that are typically prescribed to patients (12, 75). Recently, Giannobile et al. (44) reported on a study regarding risk-based approaches to evaluate tooth-loss association with either one or two annual preventive visits per year. Investigators reviewed 5,117 claims from a large insurance claims database. Patients who filed the claims did not have a prior diagnosis of periodontitis. All patients were allowed two preventive appointments per year by their insurance company, but many sought care only once per year. Patients were categorized as high risk for severe periodontitis if they had one or more risk factors for periodontitis (i.e. smoking, diabetes and interleukin-1 genetic variations). They were classified as low risk if they had none of the risk factors. For subjects with no risk factors, there was no difference in tooth loss over 16 years, regardless of whether they received one or two annual preventive appointments per year. For high-risk patients, two visits per year resulted in lower tooth loss. However,
some high-risk patients needed more than two visits per year. The authors concluded that a personalized medicine approach based on risk factors for disease may be useful in determining recall intervals for patients and would be more cost effective (44, 45).

An \textit{‘at-home’} oral self-care routine, including meticulous biofilm removal with a toothbrush and an interdental cleaning method, performed once every 24 h, is adequate to prevent gingivitis (7). However, even the best intentions do not always yield the best results. Patients have to be responsible for their oral care at home, as well as adhering to prescribed recall intervals. In recent years, there has been much discussion regarding behavioral interventions to use with patients in an attempt to produce the best oral health care.

Effective removal of plaque biofilm is a vital aspect for preventing periodontal diseases, as well as for treating existing disease (69). Several options are available to oral health-care professionals to recommend to their patients with gingivitis and chronic periodontitis, such as toothbrushing, dental floss and other interdental cleaning devices, and supra- and subgingival irrigation and oral rinsing.

\textbf{Toothbrushes}

Even though it has been suggested that meticulous removal of plaque, once daily, using a toothbrush and interdental cleaning methods, is adequate to prevent gingivitis (7), patients are generally instructed to brush their teeth twice daily. The reason for more frequent brushing is that patients brush with a manual toothbrush on average between 30 and 60 s (11, 71, 82) and only remove 60\% of the overall plaque at each brushing session (29); therefore, more frequent brushing may be necessary to increase biofilm removal. In general, studies have reported that patients who brush more than once per day, perform interdental cleaning and are consistent with professional dental care, retain more teeth over time (33, 64, 102).

Toothbrushes are designed in many shapes and sizes, using various filaments, handles and head sizes. No single toothbrush has consistently been shown to have superior plaque-removal ability over another. Although manual toothbrush designs are constantly changing and improving, efficacy is still dependent on the skill and motivation of the patient. It is generally agreed that toothbrushes should have a handle size appropriate to the age and dexterity of the user, the head design should be consistent with the size of the patient’s mouth, filaments should be no larger than 0.23 mm in diameter and toothbrushes with soft filaments should be used (21).

Powered brushes have been commercially available since the 1960s and are very popular for mechanical oral hygiene. Powered brushes are available that utilize different mechanical movements of the brush head, such as side-to-side, counter oscillation, rotation oscillation, circular, ultrasonic, iontophoresis and multidimensional. Newer models have features that are conducive to improved compliance, such as 2-min timers, pressure control, visual timers, USB traveling cases, brushing modes and interchangeable brush heads (Fig. 1). Compliance rates are good for power brush use. Stålnacke et al. (93) reported that 62\% of people continued to use their power brush on a daily basis several months after purchase.

To date, several systematic reviews have been published to determine which type of brush (powered or manual) is superior for plaque reduction and gingival health. The first review was published in 2003 and concluded that powered toothbrushes with a rotation oscillation action achieve a modest reduction in plaque and gingivitis compared with manual toothbrushing (51). The second review was published in 2005 and concluded that there was no evidence of a statistically significant difference between powered

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\caption{Example of a powered toothbrush with advanced features (Courtesy of Procter & Gamble, Cincinnati, OH).}
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and manual brushes (80). However, it was noted that rotation oscillation powered brushes significantly reduced plaque and gingivitis in both the short- and the long-term. And, at the time of publication of that review, no other powered brushes showed consistent reductions in plaque and gingivitis compared with manual brushes. The authors concluded that the clinical significance of the reduction in plaque was not known because of inconsistent methodology used in the studies and lack of standardization of the study designs. A more recent review, in 2010, compared different modes of powered toothbrushing against each other for plaque reduction and gingival health (28). Seventeen trials with 1,369 participants qualified for inclusion in the review. It was concluded that there is some evidence that rotation oscillation brushes reduce plaque and gingivitis more than side-to-side brushes in the short-term but the difference was small and the clinical significance was not clear. The challenge is that most of the studies were of short duration (<3 months), so the long-term effects on plaque and gingivitis reduction could not be evaluated. The authors concluded that ‘further research is required before evidence-based advice concerning the relative performance of the different powered toothbrushes can be given by healthcare professionals to the public’ (28). However, even though one brush may not outperform another brush, a particular patient may be more compliant with one modality over another. Fortunately, clinicians have some excellent choices in manual and powered brushes to recommend to their patients. None of the studies reported on the costs or reliability of the brushes, an important factor for clinicians to consider when recommending a power brush for use by patients.

The safety of powered brushes is sometimes asked of clinicians by their patients. In 2011, Van der Weijden et al. (101) performed a systematic review to determine the relative soft- and/or hard-tissue safety outcomes of manual toothbrushes compared with oscillating-rotating power toothbrushes. Of 697 publications initially evaluated, 35 met the eligibility criteria for inclusion in the review. The authors concluded that oscillating-rotating brushes are safe compared with manual toothbrushes and do not pose a clinical concern for physical damage to hard or soft tissues.

**Interdental cleaning**

Toothbrushing alone cannot effectively remove interproximal biofilm (20). Although toothbrushing can remove plaque up to 1 mm subgingivally, other methods are necessary for interdental removal of plaque (21). In 1815, Dr Levi Spear Parmy introduced dental floss (83). Dental flossing has been advocated, for many years, as an effective modality to remove biofilm and maintain a healthy gingiva.

Currently, dental floss is manufactured in many forms, including unwaxed, waxed, polytetrafluoroethylene, spongy, woven, tufted, expanding, thin and tape. Although some clinicians (and patients) prefer one type over another, studies indicate that there are no differences between their efficacy (17, 20).

Dental floss use is safe, and it can produce effective results, but it is a technique-sensitive procedure (34) (Fig. 2). Several systematic reviews have been conducted to assess the efficacy of dental flossing. A systematic review by Berchier et al. (13) included studies through 2007 that investigated the use of dental floss as an adjunct to toothbrushing. Of 1,166 abstracts and 187 papers, 11 publications met the inclusion criteria. The results of the meta-analysis did not show a benefit for floss on plaque and clinical parameters of gingivitis. These authors recommended that oral health-care professionals should recommend flossing on an individual-patient basis and determine if the patient has the skill and motivation to achieve the goals of the oral care regimen with this aid.

Another systematic review, by Sambunjak et al. (83), compared toothbrushing and flossing with toothbrushing alone, in adults, and its effect on periodontal disease and caries. They reviewed studies through October 2011. Twelve trials were included, which involved 582 participants who flossed in addition to using a toothbrush (intervention), and 501 participants who only used a toothbrush (control). In contrast to the systematic review by Berchier et al. (13), they concluded that there is ‘some’ evidence...
that the addition of flossing to toothbrushing reduces gingivitis in comparison with brushing alone. There was also weak evidence that flossing as an adjunct to brushing reduces plaque at 1 and 3 months. Regarding dental caries, no studies reported on the efficacy of toothbrushing plus flossing for preventing decay.

Although dental flossing is considered safe even when the technique is less than ideal (34), a major concern for the routine recommendation of using dental floss is the low compliance that is frequently cited by investigators and clinicians. The reported compliance rate for daily use of dental floss ranges from 2% (82) to 49% (6, 71, 97). An American Dental Association survey recently reported that only half of Americans (49%) say that they floss their teeth once or more a day, and 10% say that they never floss (6).

Although there is currently insufficient evidence, it has been suggested that flossing may be more effective for the reduction of dental caries (by reducing plaque biofilm in the interproximal tooth–tooth contact surfaces) than for the reduction of periodontal disease (34).

Not recommending dental floss to all patients on a routine basis probably represents a paradigm shift for most dentists and dental hygienists who were taught that all patients should perform brushing and flossing every day. The reality is that removal of the plaque biofilm is necessary for long-term maintenance of periodontal health, and it is the responsibility of the oral health-care professional to recommend the interdental cleaning method that has the best potential for successful results. This, however, may mean recommending other methods for interdental plaque biofilm control that have been shown to produce successful results and increase compliance.

### Interdental brushes

Interdental brushes have become a popular method for removing interproximal plaque biofilm. They are less technique-sensitive than dental floss and can assist patients with larger spaces in the interdental embrasure area. They have soft, nylon filaments fitted onto a stainless-steel wire and come in different shapes and sizes to fit the interdental space (Fig. 3).

A systematic review was conducted by Slot et al. (90) to determine if interdental brushes, as an adjunct to toothbrushing, are more effective than toothbrushing alone, or other interdental cleaning devices, on plaque and inflammation. The search included articles from 1965 to 2007. Of 334 titles, abstracts and Cochrane reports, nine were selected for inclusion in the review. The length of the longest study was 12 weeks. Outcome measures were plaque levels, gingivitis, bleeding and pocket reduction. Interdental brushes were found to remove more dental plaque than brushing alone, and reductions were observed in bleeding scores, gingivitis and periodontal probing measurements. When plaque index scores were compared, interdental brushes were superior to dental floss. There was no difference in the effect of the interdental brushes on gingival inflammation when compared with floss. In a review on periodontal self-care, Drisko (34) noted that even though inflammation was not reduced, one might surmise that a reduction in plaque would culminate in less inflammation. She also emphasized that more well-designed studies are needed to determine the effect of interdental brushes on reduction of gingival inflammation (34).

### Powered interdental cleaning devices

Automated interdental cleaning devices, including water irrigators/power flossers, have been introduced in recent years (Figs 4 and 5). The oral irrigator was first introduced in the 1960s and has been studied for its ability to reduce plaque, gingivitis and bleeding. Research has produced mixed results regarding the plaque-removal ability of these devices.

A study on depth of penetration using a supragingival irrigation tip was reported by Eakle et al., in 1986 (35). They found that although the depth of penetration varied according to pocket depth and tip placement, a 45° angle of an irrigation tip resulted in average penetration of 50% of the pocket depth (35). Larner et al. (66) found that the presence of calculus...
impeded the depth of penetration with an irrigator in deeper pockets (7–10 mm), but not in shallower pockets (4–6 mm). Flemmig et al. (37) compared the effectiveness of using an antimicrobial agent with water irrigation in 60 patients reporting for supportive periodontal therapy over a 6-month period. Supragingival irrigation with either water or 0.3% acetylsalicylic acid at 6 months resulted in significantly reduced gingival index scores and probing depths compared with the control group. The authors concluded that frequent supragingival irrigation with an antimicrobial agent or water, in addition to regular oral hygiene, was beneficial to professional periodontal supportive care. In another study, by Flemmig et al. (38), irrigation with a low concentration of chlorhexidine (0.06%) was shown to reduce plaque and gingival inflammation. In addition, it was more effective than rinsing with chlorhexidine (0.12%) or irrigation with water (38, 65).

Patients can also be advised to include subgingival irrigation in their daily oral hygiene routine. Eakle et al. (35) investigated the effectiveness of the oral irrigator as a vehicle for delivering an aqueous solution into periodontal pockets. Using a 90° angle of application, the pocket penetration was 71% for shallow pockets, 44% for moderate pockets and 67% for deep pockets, with a maximum pocket penetration of 4–5 mm. A study by Braun & Ciancio (15) reported that when using a tip designed to perform subgingival irrigation (Pik Pocket®; WaterPik Technologies, Fort Collins, CO), the irrigant could access 90% of the depth of a 6-mm pocket and 64% of the depth of pockets ≥7 mm. This is in comparison with rinsing, which showed a penetration of only 21% in pockets ≤6 mm. Even though the efficacy of irrigation as a once-only treatment after scaling and root planing is questionable (47), it is an option for patients to utilize during daily oral home care. However, patients must be instructed on the proper placement of the tip, as well as the force of the irrigant (Fig. 6).

Greenstein (47) conducted an extensive review of the literature for the American Academy of Periodontology and published a position paper entitled, The Role of Supra- and Subgingival Irrigation in the Treatment of Periodontal Diseases, which was published in 2005. Although not a systematic review, it contains valuable information for clinicians. He concluded that supragingival and marginal irrigation is valuable
as an adjunctive treatment for patients with gingivitis and in the home-care routine for patients with periodontitis (26, 47). Specifically, he noted:

Conceptually, the greatest advantage of self-administered subgingival irrigation is that it permits patients to participate in maintaining the bacterial reduction that was attained during root planing. Previously, patient participation was limited to supragingival brushing and interdental cleaning. Subgingival irrigation allows individuals to actively engage in self-therapy at problem sites and potentially have a direct effect on the microflora (47).

In 2008, Husseini et al. (53) reported, in a systematic review, on the adjunctive effect of oral irrigation, in addition to toothbrushing, on plaque and clinical parameters of periodontal inflammation. Of 813 titles and abstracts, 27 full-text papers were identified. Seven studies, using a randomized controlled clinical trial, were identified for inclusion in the review. Three of seven studies used a ‘toothbrush only’ group as the control, and four of seven studies used a ‘regular oral hygiene’ group as the control. The results indicated that oral irrigation did not have a beneficial effect for plaque removal above that of ‘toothbrushing’ or ‘regular oral hygiene’, with six of seven studies demonstrating no significant difference where data were available. However, oral irrigation did show significant beneficial adjunctive effects over ‘regular oral hygiene’ alone in reduction of bleeding on probing in all three studies for which data were available, significant reduction in gingival indices in three of four studies for which data were available and reduction in pocket depth in two of three studies for which data were available.

The authors provided plausible explanations regarding the reduction in bleeding and other parameters of periodontal disease with oral irrigation (53). First, when regular supragingival irrigation is performed by patients exhibiting gingivitis, the composition of the key pathogens may be altered, reducing inflammation (37). Second, there may be a beneficial effect of the flushing away of food debris, loosely adherent plaque and bacterial cells, which may interfere with plaque maturation (41). Third, plaque thickness may be reduced by irrigation that would remain undetected using current evaluation systems (58). Fourth, water pulsations may change the subgingival microbial environment, leading to a reduction in inflammation (18). The authors also concluded that although supragingival irrigation delivers considerable force to the gingival tissues, it appears to be safe for healthy patients (53).

**Antimicrobial mouthrinses**

Antimicrobial mouthrinses have been investigated as a mechanism to reduce plaque and gingivitis. About 20% of the oral environment is occupied by tooth surfaces, which are the areas targeted for toothbrushing and flossing (72). Dental plaque biofilm is not limited to tooth surfaces. The remaining 80% of the oral environment includes the oral mucosa and specialized mucosa of the tongue (72). These areas can serve as reservoirs for bacteria. Theoretically, a mouthrinse can have an antibacterial effect on the entire mouth, including areas that may have been missed after using other mechanical aids, such as a toothbrush or interdental cleaning devices.

The most widely investigated antimicrobial mouthrinses are those containing chlorhexidine gluconate, essential oils and cetylpyridinium chloride. Van Strydonck et al. (103) conducted a systematic review to determine the efficacy of chlorhexidine mouthrinses on plaque, gingival inflammation and staining in patients with gingivitis. Studies of ≥4 weeks were included. After reviewing 1,355 titles, 30 publications qualified for inclusion. The majority of studies found chlorhexidine to be an effective adjunct to oral hygiene methods for the reduction of plaque, bleeding and gingivitis. The percentage reduction was 33% for plaque and 26% for gingivitis. These percentages are well within the guidelines set forth by the American Dental Association Council on Scientific Affairs, which state that for a product to be efficacious, the active group must show an improvement of at least 15% over that of the control group (1). In addition, the American Dental Association noted that the studies to determine efficacy should evaluate the ability of the test product to reduce gingivitis and to inhibit, or reduce, plaque formation or plaque pathogenicity. Although rinsing with chlorhexidine does not completely eliminate plaque, it is an effective adjunct to the mechanical removal of plaque that can lead to a reduction in gingivitis. The systematic review did show a significant increase in staining scores, so chlorhexidine rinse is typically prescribed for short-term use (103).

Another systematic review was conducted by Gun- solley (48) to evaluate the efficacy of anti-gingivitis and anti-plaque dentifrices and mouthrinses in 6-month trials. Of 80 full-length published and unpublished reports, 50 met the inclusion criteria. He
concluded that chlorhexidine and essential oil rinses had consistent anti-plaque effects. Cetylpyridinium chloride showed inconsistent results, probably because of the variety of the formulations. For example, some contained alcohol, whereas others did not. The formulations varied from 4.5% cetylpyridinium chloride to 7% cetylpyridinium chloride. Only two studies reported the results of a 7% formulation with one containing alcohol and the other without alcohol. For reduction of the clinical signs of gingivitis, both the chlorhexidine rinse and the essential oils rinse showed statistically and clinically significant reductions. Mouthrinses containing essential oils had approximately 60% of the anti-gingivitis and anti-plaque effect of 0.12% chlorhexidine rinse. In 2008, Haps et al. (49) conducted a systematic review of cetylpyridinium chloride to assess its efficacy as an adjunct to daily oral hygiene for the reduction of plaque and gingivitis. All studies in the review had to be at least 4 weeks in length. They concluded that cetylpyridinium chloride-containing mouthrinses provide a small, but significant, additional benefit in reducing plaque (weighted mean difference = −0.50; \( P < 0.00001 \)); and gingivitis (weighted mean difference = −0.25; \( P < 0.00003 \)) compared with toothbrushing alone or toothbrushing in conjunction with a placebo mouthrinse (49).

Stoeken et al. (99) reported on a systematic review of the effect of essential oils on plaque and gingivitis reduction, in studies of \( \geq \)6 months. Of 566 papers, 11 publications met the criteria for inclusion. The results supported strong evidence regarding the efficacy of essential oils for plaque and gingivitis reduction. A statistically significant reduction in overall gingivitis was noted compared with the control (weighted mean difference = −0.32; 95% confidence interval: −0.46 to −0.19; \( P < 0.00001 \)). Although a meta-analysis could not be conducted to evaluate the effect of essential oils on tooth staining, the studies which did evaluate this found that essential oils did not promote the development of extrinsic tooth stain.

Sodium hypochlorite (i.e. household bleach) is a potent disinfectant that, after dilution, has been used recently as an antimicrobial mouthrinse (30, 43, 46, 59, 91) or irrigant (68). Rinsing with dilute solutions of bleach has produced marked reductions in plaque scores and signs of gingival inflammation, such as bleeding on probing, even in untreated deep periodontal pockets (30, 43, 46). These results merit investigations in large clinical trials.

Several chlorine-containing over-the-counter mouthrinses are currently commercially available (32, 60, 76, 92, 107). Most of these preparations are sold as anti-halitosis products (42, 76), but they are also known to have antimicrobial activities (32, 107). None of these chlorine dioxide-containing mouthrinses have been carefully evaluated for their potential anti-gingivitis effects.

Patient interest in using oral care products containing natural compounds has increased in recent years as these products are viewed as being a safer choice than the synthetic products that are typically commercially available (23). Chen et al. (19) conducted a systematic review of natural-compound-containing mouthrinses as an adjunct to unsupervised oral hygiene in the control of plaque and gingivitis. Of 2,236 titles and abstracts, 11 were selected for inclusion. These 11 studies investigated 13 different natural-compound-containing mouthrinses. A meta-analysis could not be conducted because of the variation in patient demography, study design, study length and number of studies per product. Unfortunately, only one mouthrinse had been studied in two independent trials. The authors concluded that the evidence is insufficient to support the efficacy of natural-compound-containing mouthrinses as an adjunctive method for plaque and gingivitis reduction. They also stressed the need for increased high-quality studies of natural compounds because of the potential oral health benefits of these compounds.

Antimicrobial rinses have been evaluated as an adjunct to daily brushing and flossing in several investigations. Three studies have been conducted on the anti-gingivitis and anti-plaque effects of essential oils in relation to mechanical plaque control. The findings were that essential oils have a significant effect when used as an adjunct to dental floss and, in some cases, performed better than floss alone (10, 87, 88). Based on these results, dental professionals might consider the benefits of a daily regimen of brushing, interdental cleaning and antimicrobial rinsing to improve plaque and gingivitis control.

There are factors, other than efficacy, to consider that may influence patient acceptance of mouthrinses in a daily regimen, such as taste alteration, staining, burning, increase in calculus formation and cost. Addy (2) has provided an extensive review of these factors in a previous volume of Periodontology 2000.

The advantages of an antimicrobial rinse are that they are quick, easy to use and relatively inexpensive. Patients are instructed to use the product twice daily for approximately 30 s. Most of the products do not require a prescription, so they are readily available to patients. Patients must weigh their options about the products they elect to use and make decisions about how they wish to spend their time and resources to
achieve oral health. Dentists and dental hygienists can be invaluable in making specific patient recommendations.

Dentifrices

Toothbrushing with toothpaste is the most common method utilized for plaque removal (40). Dentifrices are available in various formulations, such as stannous fluoride/sodium hexametaphosphate, amine fluoride/stannous fluoride, triclosan (2′,4′-hydroxy-2,4,4′-trichlorodiphenyl ether), essential oils, sodium bicarbonate, quaternary ammonium compounds, zinc citrate or zinc chloride (2, 34).

Dentifrices such as those containing stannous fluoride, triclosan and chlorhexidine have been formulated to assist in the reduction of plaque and gingivitis. However, very few systematic reviews have been published to provide evidence for use of the different formulations. A systematic review was conducted by Hioe and van der Weyden (52) to assess the effectiveness of self-performed mechanical plaque control with a triclosan [5-chloro-2-(2,4 dichlorophenoxy)phenol]-containing dentifrice. The authors identified 105 titles and abstracts, and 18 trials were included in the final analysis. The authors concluded that of studies ≥ 6 months in length in patients with gingivitis, the triclosan dentifrice produced a significant, albeit small, positive effect on the reduction of plaque (weighted mean difference = −0.10; 95% confidence interval: −0.13 to 0.05) and gingivitis (weighted mean difference = −0.24; 95% confidence interval: −0.35 to −0.13).

As noted earlier, Gunsolley (48) conducted a meta-analysis of anti-plaque and anti-gingivitis agents. Fifty articles were included in the analysis. Dentifrices containing stannous fluoride resulted in a statistically significant, but small, anti-plaque effect, but they produced a statistically and clinically significant effect on gingivitis. Of the triclosan formulations, the only one that resulted in statistical and clinical significance for an anti-plaque and anti-gingivitis effect was the dentifrice containing triclosan with 2.0% Gantrez™ Copolymer (48). The review by Gunsolley (48) concurs with that of Davies et al. (27) who performed a systematic review of triclosan/copolymer dentifrice. They found that triclosan/copolymer improved both supragingival plaque and gingival health in subjects who utilized the dentifrice unsupervised for at least 6 months (27).

The safety of triclosan has been questioned in recent years by the scientific community in several countries. Triclosan is a broad-spectrum antimicrobial that is used in detergents, soaps and toothpaste. Studies have been published reporting detrimental effects to overall health (3, 4), as well as to the environment (62), with the use of triclosan products. In 2013 the Food and Drug Administration reported that the studies conducted on triclosan showed that its use in the dental setting is safe and effective (39). Several studies that were conducted for at least 6 months reported that triclosan does not promote microbial resistance and does not cause a shift in the normal oral microbial ecosystem (9, 81). A systematic review by Riley & Lamont (79) reported that after reviewing 30 randomized controlled trials utilizing a triclosan toothpaste, there was no evidence of any harmful effects associated with the use of the toothpaste in studies up to 3 years in length. More recently, Cullinan et al. (25) studied dental samples collected from 40 individuals during the fifth year of a randomized controlled trial that studied the effectiveness of triclosan toothpaste in slowing the progression of chronic periodontitis in a group of subjects with cardiovascular disease. The continuous use of triclosan toothpaste did not result in the development of a triclosan-resistant bacterial population in the oral biofilm (25). In 2014, Haraszthy et al. (50) reported on a study of 155 dental plaque samples that were collected at 11 different times over 19 years. Fifty-eight of the 155 subjects from whom the plaque samples had been collected had used triclosan toothpaste for at least 5 years, whilst 97 had used a toothpaste that did not contain triclosan. There were no changes in antimicrobial susceptibility in either group. Although current evidence supports the safety of triclosan-containing toothpaste in respect to the oral cavity, triclosan products will continue to be monitored by the Food and Drug Administration and evaluated for systemic safety.

The efficacy of chlorhexidine as a mouthrinse regimen for plaque and gingivitis control has been extensively investigated. Recently, a review was conducted by Slot et al. (89) to evaluate the effect of a chlorhexidine dentifrice/gel compared with a placebo dentifrice/gel on plaque and gingivitis scores in healthy adults. Three-hundred and eighty-nine papers and abstracts were searched, and 16 papers were selected for inclusion in the review. The authors concluded that chlorhexidine dentifrice provided a significant, positive effect on reduction of plaque in most studies and reported a significant reduction in gingival bleeding in all studies for the dentifrice. The chlorhexidine gel did not show a beneficial effect. Tooth discoloration was also observed following use of the
chlorhexidine dentifrice. Although the results obtained following use of the chlorhexidine dentifrice were positive, the fact that chlorhexidine dentifrice does not contain fluoride may prevent it from being the best choice for routine oral home care.

Paraskevas & van der Weijden (74) conducted a review of stannous fluoride-containing dentifrices on gingivitis reduction. Of 542 papers identified, 36 were selected for inclusion in the review. A statistically significant reduction in gingivitis was noted in comparison with controls, but inconsistent results were found in plaque reduction. The authors concluded that the use of stannous fluoride-containing dentifrices resulted in gingivitis and plaque reduction when compared with a conventional dentifrice, but the extent of the difference could not be evaluated because of a high level of heterogeneity in study outcomes.

**Oral health behavior and oral health education**

Dentists and dental hygienists have many options to recommend to patients for safe and effective home care to treat mild and moderate periodontal disease. But what can clinicians do to increase adherence to recommendations and potentially improve oral health? The dynamics of health-behavior change can be among the most challenging and most rewarding aspects of patient care. Utilizing counseling approaches with demonstrated success in achieving and sustaining preventive-care practices benefit patients and providers alike.

Treatment of periodontal diseases requires a combination of optimal therapy and daily oral hygiene. Daily plaque removal through proper toothbrushing and interproximal cleaning is an essential accompaniment to professional scaling for successful treatment of periodontal disease. Adherence to such professional recommendations is, however, astonishingly low. Studies on adherence to health professionals’ recommendations have shown that approximately 30–60% of health information provided in the clinician/patient encounter is forgotten within an hour and that 50% of health recommendations are not followed (31). Overcoming persistent noncompliance can make health-behavior change one of the most rewarding and the most challenging responsibilities for dental health professionals.

Ideal oral-hygiene-behavior change is sustainable and requires minimal reinforcement. The traditional prescriptive and educational interventions have been shown to be ineffective in achieving long-term behavior change. The contemporary field of oral health behavior and oral health education has considerably and now reflects a blending of theory, strategies and approaches between the social and health sciences.

This increased interest in the psychosocial aspects of behavior change is evident in a recent systematic review of interventions to improve oral hygiene based on psychological models (78). The systematic search of the literature retrieved 456 publications. Whilst papers must have clearly stated that a psychological model or theory was used, the authors lamented that most were rejected from the review based on omission of key constructs of the theories in the study design. Only four studies explicitly used a psychological model as the basis for an intervention (67, 96, 98, 106). Each of these four studies adopted a different theoretical model, rendering meta-analysis unfeasible. The results of the two studies that used a randomized control design on a combined 207 subjects (67, 96) demonstrated that psychological interventions resulted in improved plaque scores compared with negative controls. One of these two studies, using a randomized clinical control design of 107 subjects, found a significant additional decrease in gingival bleeding on probing and in pocket-depth reduction for pockets with initial measurements of 3–6 mm in the psychological intervention group compared with the control group (67). Only one study examined the impact on beliefs and attitudes with improved self-efficacy in relation to flossing compared with positive and negative controls (98). Despite the common prescriptive, information-giving approach to behavior change that is commonly employed by dental providers, no effect was found on dental knowledge or self-efficacy beliefs in relation to brushing (98).

In addition to psychological models, a number of well-established counseling strategies provide alternative approaches to eliciting behavior change. Motivational interviewing is a well-accepted strategy, aimed at behavior change, to improved plaque control and clinical periodontal outcomes (Table 1). Jönsson et al. (57) found that in patients with chronic periodontitis, nonsurgical periodontal maintenance motivational interviewing, with self-monitoring and goal-setting, significantly reduced gingival inflammation (77% vs. 46%) and plaque (81% vs. 57%) compared with traditional oral education. Almomani et al. (5) also demonstrated, among a sample of severely and persistently mentally ill patients, that motivational interviewing improved plaque scores and knowledge when added to oral health education. As a result of the paucity of oral health providers with
motivational interviewing training, four other current studies have been conducted with either oral health providers trained in motivational interviewing or surrogate nondental counselors to provide counseling intervention (55, 56, 86, 95). Jönsson et al. (55) compared an individually tailored oral health educational program on periodontal health with a standard oral health educational program and investigated if either resulted in differences 12 months post-treatment. The individually tailored oral health educational program group had lower bleeding on probing scores and reached a level of treatment success greater than the control group at the 1-year evaluation. Another study by Jönsson et al. (56) investigated the cost effectiveness of an individually tailored oral health educational program in nonsurgical periodontal treatment cases. They found that more individuals in the individually tailored oral health educational program group than in the control group achieved the predetermined criteria for treatment success. Furthermore, the incremental costs for the individually tailored oral health educational program were low, suggesting that incorporation of an individually tailored oral health education program should be considered compared with incorporation of a standardized education program. Shamani and Jansson (86) conducted a study to investigate the frequency of smoking cessation and the use of proximal tooth-cleaning routines by patients after nonsurgical periodontal treatment and a conversation about oral health. They also sought to evaluate if the behavioral changes had any effect on periodontal healing. The study was conducted as a retrospective longitudinal study with no control group. The results did not show any change in patient behavior. The authors suggested increased education of dental hygienists in the area of behavioral change. Stenman et al. (95) found that a motivational interviewing intervention resulted in a negligible decrease (3–4%) in the marginal gingival bleeding index and plaque index that was not significantly different from the changes observed in the control group without any intervention.

Dental and dental hygiene students alike have been successfully trained in motivational interviewing (16, 24, 61). The evidence previously presented, demonstrating enhanced and sustained oral-health-behavior change and improved periodontal outcomes, supports the need to expand the training of oral health-care providers in motivational interviewing. The following brief review of the spirit and strategies of motivational interviewing counseling will focus on how this approach might be used to elicit oral-health-behavior change within the dental counseling atmosphere. The key components of brief motivational interviewing, which can be applied for the delivery of oral health information and advice, are: Ask permiss-

<table>
<thead>
<tr>
<th>Author (ref. no.)</th>
<th>Background and motivational interviewing training of counselor</th>
<th>Duration and number of motivational interviewing sessions</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jönsson et al. (55–57)</td>
<td>Master’s level registered dental hygienist with 3-day workshop and video training</td>
<td>Eight to nine 10-min motivational interviewing interventions over 2 years of treatment compared with traditional treatment</td>
<td>Reduced gingival inflammation (77% compared with 46%) and plaque (81% compared with 57%)</td>
</tr>
<tr>
<td>Almomani et al. (5)</td>
<td>‘Trained’ doctoral psychology student supervised by a motivational interviewing expert</td>
<td>One, 15–20 min, session plus traditional patient education</td>
<td>The motivational interviewing group had significantly less plaque after 8 weeks (effect size $n^2 = 0.8$)</td>
</tr>
<tr>
<td>Shamani &amp; Jansson (86)</td>
<td>Periodontist and registered dental hygienist, no mention of training</td>
<td>‘Motivation’ intervention of unknown frequency or duration over a mean of 9.8 months of treatment</td>
<td>Daily interproximal cleaning increased from 56% to 72%</td>
</tr>
<tr>
<td>Stenman et al. (95)</td>
<td>Clinical psychologist with ‘extensive experience in motivational interviewing’</td>
<td>Single, 20–90 min, motivational interviewing session plus traditional patient education over 6 months of treatment</td>
<td>Motivational interviewing intervention resulted in a negligible decrease in bleeding index and plaque index that was not significantly different from the control group</td>
</tr>
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</table>
sion; Elicit–Provide–Elicit; Sort options; and Obtain commitment.

**How does motivational interviewing differ from traditional oral hygiene instruction?**

Motivational interviewing is a person-centered, goal-directed method of communication for eliciting and strengthening intrinsic motivation for positive change (73). It is predicated on a ‘spirit’ of rapport, based on partnership and acceptance. As such, the motivational interviewing counselor must be willing to hear, accept and respond to a patient’s personal perspective rather than recite a predetermined set of prescribed instructions. For example, as educated professionals, dentists and dental hygienists typically assume the role of the authority or expert, giving a prescribed explanation of the disease process, whereas motivational interviewing indicates that it is a directed method of communication; it is the thoughtful use of techniques and strategies responsive to the client’s desire for information that is unique.

OARS is the acronym for the four core communication skills – open-ended questions, affirmations, reflections and summary – that are integral to the collaborative, client-centered motivational interviewing approach. Whilst many of these are not new concepts, their collective and strategic use are the essence of the spirit of motivational interviewing. Many aspects of our dental visits are routinely closed-ended. Medical history questions seek yes/no answers, whereas the types of oral hygiene used generate short categorical responses. Open-ended questions serve two main purposes. First, it develops the partnership by showing the patient we really hear what they have to say. The intent is to listen for responses that represent change talk (in the direction of the desired change) or sustain talk (avoiding change) that will be discussed further. Second, if we are unsure we understood the patient correctly, it provides an opportunity to clarify meaning. Varying levels of reflections, from simple repetition of what the client said, to amplified reflections that exaggerate the response, help direct the patient in the direction of the health-behavior change we both wish to achieve. Skilled reflections allow the provider to interpret the meaning of the patient’s responses. The following vignette illustrates this concept. The patient was just shown how to use Superfloss® (Oral-B/Procter & Gamble Co., Cincinnati, OH) for interdental cleaning.

Clinician

*What did you think of the Superfloss®?* (Open-ended question)

Patient

*Well I don’t like the deep pockets you found this visit.*

Clinician

*The deep pockets worry you.* (Complex reflection)

Notice the reflection is made as an interpretive statement, not a question. A good method to use when beginning to use reflective statements is the phrase, ‘Sounds like...’. In the example above it would change to, ‘Sounds like, the deep pockets worry you.’ Once you become accustomed to using reflections, simply drop the ‘Sounds like.’

Affirmations are used to acknowledge and encourage the positive health behaviors that patients are already practicing. If a patient sheepishly states that they are only flossing once or twice a week, knowing they should do it every day, displaying our approval with an affirmation may serve to enhance the patient’s confidence. Affirmations combined with other OARS allow the provider to direct the conversation toward

ended questions are those which require something other than a yes/no or brief categorical answer. Sometimes even questions that seek to elicit individualized information from patients end up closed-ended. For example, ‘Have you ever thought about more frequent recall visits as a means of preventing gum disease?’ Typically, the question will be open-ended if it starts with ‘What’ or ‘How.’ Another effective means of achieving open-ended questions is to start with, ‘Tell me about...’ or ‘Can you tell me?’

The R in OARS stands for reflective listening. Reflections of patients’ responses to open-ended questions serve two main purposes. First, it develops the partnership by showing the patient we really hear what they have to say. The intent is to listen for responses that represent change talk (in the direction of the desired change) or sustain talk (avoiding change) that will be discussed further. Second, if we are unsure we understood the patient correctly, it provides an opportunity to clarify meaning. Varying levels of reflections, from simple repetition of what the client said, to amplified reflections that exaggerate the response, help direct the patient in the direction of the health-behavior change we both wish to achieve. Skilled reflections allow the provider to interpret the meaning of the patient’s responses. The following vignette illustrates this concept. The patient was just shown how to use Superfloss® (Oral-B/Procter & Gamble Co., Cincinnati, OH) for interdental cleaning.

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the desired behavior change, which, in this case, is more frequent use of floss, without making the patient feel guilty or wrong about what they are currently doing, and might be expressed by the phrase ‘Great. I am glad to hear you are using the floss every week. What do you think makes the times you use it work well for you?’

The last OARS is summary. Summaries reiterate the fact that we were truly listening, whilst setting the stage for behavior change. The art is to summarize any aspects of the conversation, allowing the patient to hear any contradictions in their own responses with a focus on what they want to do next.

Motivational Interviewing is a communication style that pays particular attention to the language of change referred to as ‘change talk.’ Strategies are aimed at eliciting change talk (in the direction of the desired change) whilst minimizing or redirecting ‘suspend talk’ (avoiding change). The four processes – engaging, focusing, evoking and planning – strengthen a patient’s own motivation for, and commitment to, change. Beyond OARS, more sophisticated motivational interviewing strategies are aimed specifically at evoking and planning intrinsic motivation for behavior change. Once again, the plan ultimately originates from the patient with direction from the clinician. After all, what are you more likely to do? That which you have been told to do, or that which you offer to do?

**Strategies for evoking and planning**

Whilst it is not possible, within the confines of a single article, to examine all motivational interviewing strategies for eliciting and responding to change talk (planning), a few key methods should be highlighted. One of the simplest means of eliciting change talk is the use of evocative open-ended questions. Evocative questions focus responses on preparatory change talk, expressed as Desire, Reason, Ability or Need statements, such as:

- *Why would you want to make this change?* (Desire)

- *How might you go about it, in order to succeed?* (Ability)

- *What are the three best reasons for you to do it?* (Reasons)

- *How important is it for you to make this change?* (Need)

  **So what do you think you’ll do?** (Commitment)

Responses to evocative questions might even include expressed commitment to change, action toward change, or taking steps toward making a change. These are the ultimate goals of motivational interviewing.

Decisional balance is another useful strategy for evoking and planning. It is a means of allowing the patient to examine the pros and cons of a behavior change. This strategy is particularly helpful for patients who are ambivalent or uncertain about making a change. Smoking cessation is a good example. Patients are often defensive about conversations on smoking cessation, yet, as a significant risk factor for periodontal disease, clinicians need to address this behavior. As such, in the case of smoking cessation, a decisional balance approach might be:

**Clinician**

I see on your medical history you smoke cigarettes. Would it be okay if we talked a little bit about smoking? (Ask permission)

**Patient**

I suppose. But I am not at all interested in quitting at this time. (Resistance)

**Clinician**

While you’ve thought about quitting now is not a good time, (Reflection/Rolling with Resistance) tell me what you like about smoking? (Open-ended question examining pros)

**Patient**

It just helps me relax.

**Clinician**

When you are stressed, smoking helps you relax. (Reflection). What else?

**Patient**

My buddies and I smoke during breaks at work and when we are going out for a drink. It also helps me keep from gaining weight.

**Clinician**

You have friends that smoke and you do not want to gain weight if you quit. (Evocative, but hypothetical, question because the patient stated that they were not ready to quit).

**Patient**

Not really.

**Clinician**

What would be some of the benefits if you did decide to quit? (Evocative, but hypothetical, question because the patient stated that they were not ready to quit).

**Patient**

I would save money I guess.

**Clinician**

Cigarettes are expensive. (Reflection) What else?
Patient
Well, I know it would be better for my health. (Reason)

Clinician
The effects of smoking on your health are a concern. (Reflection) What else?

Patient
I'd like to quit so my kids don't see me smoking and think it is okay to start. (Desire)

Clinician
You want to be a good role model for your kids. (Reflection)

Patient
Yeah.

Clinician
So on the one hand you are not ready to quit because smoking helps you relax, your friends and co-workers smoke, and you do not want to gain weight. On the other hand, if you did quit you would save money, be healthier and perhaps discourage your kids from smoking. (Summary ending with reasons to quit) Where does that leave you? (Evocative question)

In the example above, ‘What else’ often follows the reflection to keep the patient thinking and talking. The motivational interviewing strategies examined are ultimately aimed at directing the patient to generate commitment language. These statements vary from low levels of commitment to high levels of commitment (Fig. 7).

OARS are used following commitment language to direct the patient to generate a plan. When the patient derives the plan they are more likely to make the expressed changes to achieve their goals.

Motivational interviewing has shown preliminary value for impacting oral behaviors to improve plaque removal and reduce gingival inflammation. The training and experience of dental providers vary widely, making comparisons of study results difficult. Further research with standardized methodologies is needed to determine the utility of motivational interviewing for improving periodontal outcomes.

Conclusions

It is expected that general dentists and dental hygienists will diagnose and treat more cases of mild-to-moderate periodontal disease in the future. It is generally accepted that probing depths and clinical attachment levels can be improved with supragingival and subgingival scaling and root planing, coupled with consistent and meticulous self-care and routine professional appointments with oral health-care providers. Oral self-care seems to be realistic; a daily routine of brushing twice daily and interdental cleaning once daily should take less than 10 min for most patients. However, we know from the literature and from observing patients in practice that adherence to a regimen may be sporadic or nonexistent.

Many clinicians recommend that patients report to their dental practice/clinic twice per year. Although this regimen may be appropriate for some patients, it does not apply to all. Currently, little evidence exists for a twice-yearly dental visit. Some patients need to return for professional services less frequently or more frequently. Clinicians need to assess each patient on an individual basis to determine the most appropriate recall intervals. In the future, clinicians may establish risk factors for oral disease as a measure to decide the optimal intervals for patients to attend dental professionals.

Clinicians have many plaque-removal device options that patients can use for oral self-care. If performed correctly and thoroughly, brushing with either manual or powered brushes can remove plaque biofilm. Control of plaque biofilm in the interdental areas can be managed with floss, interdental brushes and powered devices. Some antimicrobial mouthrinses have also been shown to reduce plaque biofilm over and above that achieved by brushing and interdental cleaning.

Two additional challenges to compliance with oral self-care are patient memory regarding instructions.

Low Commitment
- I'll think about it
- I plan to
- I will try to

High Commitment
- I will
- I intend to
- I am ready to

Fig. 7. Commitment statements generated by patients following motivational interviewing.
and motivation to adhere to recommendations. The literature suggests that strategies based on the clinician ‘telling’ the patient what they need to do for improved oral hygiene do not work (14, 63). Rather, social and health sciences suggest that utilizing strategies which will elicit change talk (such as motivational interviewing) will probably produce better and lasting results. However, there is a paucity of evidence on what works best for oral-health-behavior change. More research is needed in this important area. In particular, motivational interviewing has shown positive results regarding improved oral health outcomes, such as reducing plaque scores and gingival inflammation. Motivational interviewing training is just starting to be employed in dental and dental hygiene programs. There are also training courses available for clinicians to learn these behavioral strategies. As general dentists and dental hygienists are treating increasing numbers of patients with mild-to-moderate periodontitis, it is prudent for them to stay abreast of the evidence regarding in-office and at-home therapies, as well as learning strategies to utilize in patient education, to achieve increased adherence with oral self-care.

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