J Clin Periodontol 2004; 31: 1029–1033 doi: 10.1111/j.1600-051X.2004.00614.x

Journal of Clinical Periodontology

The effectiveness of a toothpaste containing Triclosan and polyvinyl-methyl ether maleic acid copolymer in improving plaque control and gingival health

A systematic review

R. M. Davies[1], R. P. Ellwood[1] and G. M. Davies[2]

[1]Dental Health Unit; [2]Central Manchester Primary Care Trust, Manchester, UK

Davies RM, Ellwood RP, Davies GM: The effectiveness of a toothpaste containing Triclosan and PVM/MA in improving plaque control and gingival health. A systematic review. J Clin Periodontol 2004; 31: 1029–1033. doi: 10.1111/j.1600-051X.2004.00614.x. © Blackwell Munksgaard, 2004.

Abstract

Objective: To compare the effectiveness of triclosan/copolymer and fluoride dentifrices in improving plaque control and gingival health.

Search strategy: We searched the Cochrane Controlled Trials Register, MEDLINE (1986 to March 2003) and EMBASE (1986 to March 2003). Personal files and the reference lists of all articles were checked for further studies.

Selection criteria: Trials were selected if they met the following criteria: random allocation of participants; participants were adults with plaque and gingivitis; unsupervised use of dentifrices for at least 6 months; and primary outcomes – plaque and gingivitis after 6 months.

Data collection and analysis: Two reviewers independently extracted information. For each plaque and gingivitis index, the mean differences for each study were pooled as weighted mean differences (WMDs) with the appropriate 95% confidence intervals (CIs) using the random effect models.

Main results: Sixteen trials provided data for the meta-analysis. The triclosan/copolymer dentifrice significantly improved plaque control compared with a fluoride dentifrice, with a WMD of −0.48 (95% CI: −0.64 to −0.32) for the Quigley–Hein index and WMD of −0.15 (95% CI: −0.20 to −0.09) for the plaque severity index. When compared with a fluoride dentifrice, the triclosan/copolymer dentifrice significantly reduced gingivitis with WMDs −0.26 (95% CI: −0.34 to −0.18) and −0.12 (95% CI: −0.17 to −0.08) for the Loe and Silness index and gingivitis severity index, respectively.

Key words: gingivitis; plaque; systematic review; triclosan/copolymer toothpaste

Accepted for publication 15 March 2004

Twice daily brushing with a fluoride toothpaste is now an integral part of most people's daily hygiene routine and has contributed significantly to the dramatic decline in dental caries. While the mechanical removal of plaque per se on caries is equivocal, the maintenance of an effective plaque control programme is the cornerstone of any attempt to prevent and control periodontal diseases. Despite the fact that 74% of dentate adults in the UK claimed to brush their teeth twice a day (Morris et al. 2001) 72% had visible plaque on at least one tooth with the mean proportion of teeth affected increasing from 30% in 25–34-year olds to 44% in those aged 65 years and above. Clearly most individuals find it difficult to maintain an effective level of plaque control and this is reflected in the

Robin Davies and Roger Ellwood are employees of Colgate Ltd, UK.

levels of periodontal disease in the population. Approximately 50% of those aged 25 years and above had moderate periodontal disease (pocket depth, 4–6 mm) and there was a steady increase in the prevalence of severe disease (pocket depth, >6 mm), ultimately affecting 15% of people aged 65 years and above. Similar levels of moderate and advanced disease are found in Europe and North America (Albandar 2002, Sheiham & Netuveli 2002). In an effort to improve the effectiveness of plaque removal and periodontal health triclosan, a broad-spectrum antibacterial agent has been added to toothpastes. Although compatible with other toothpaste ingredients, triclosan per se is not substantive and one approach to boost its effectiveness was to increase the retention of triclosan in the mouth by the addition of a polyvinyl-methyl ether maleic acid copolymer. In vitro studies demonstrated that the copolymer increased the uptake and retention of triclosan, and short-term studies demonstrated the potential of a formulation containing 0.3% triclosan and 2% copolymer to enhance plaque removal and improve gingival health (Nabi et al. 1989, Gaffar et al. 1994).

A series of randomised controlled clinical trials have been completed and the results have been summarised in a number of traditional reviews (Volpe et al. 1996, Drisko 2001). The objective of this systematic review was to evaluate the effectiveness of a dentifrice containing 0.3% triclosan, 2% copolymer and 0.243% sodium fluoride in a silica base (Colgate Total, The Colgate-Palmolive Company, NY, USA) in controlling plaque and gingival inflammation when compared with a fluoride dentifrice or no intervention.

Method

This review was conducted using the methodology developed by the Cochrane collaboration. Randomised trials, of at least 6 months' duration, conducted on adults with plaque and gingivitis comparing a dentifrice containing 0.3% triclosan, 2% copolymer and 0.243% sodium fluoride in a silica base with a fluoride dentifrice for plaque or gingivitis were eligible for inclusion in the review. Trials reported in any language were eligible for inclusion and we intended to have non-English reports of trials translated. A free text search of the Cochrane Controlled Trials Register, MEDLINE (from 1986) (restricted to controlled clinical trials and randomised clinical trials and up to March 2003) and EMBASE was carried out for the term ''triclosan''.

Personal files and the reference lists of all articles were checked for further studies.

Two reviewers (R.D. and G.D.), independently and in duplicate, selected the papers to be read and decided their eligibility for inclusion. Data extraction was carried out independently and any disagreements were resolved by discussion. Both reviewers also carried out a quality assessment of the trials.

Results

Description of trials

The search strategy produced over 250 citations, 16 of which were identified as eligible for inclusion in this review (Garcia-Godoy et al. 1990, Cubells et al. 1991, Deasy et al. 1991, Bolden et al. 1992, Denepitiya et al. 1992, Mankodi et al. 1992, Lindhe et al. 1993, Svatun et al. 1993, Triratana et al. 1993, Palomo et al. 1994, Kanchanakamol et al. 1995, Renvert & Birkhed 1995, Hu et al. 1997, McClanahan et al. 1997, Allen et al. 2002, Triratana et al. 2002) according to the defined criteria for study design, participants, interventions and outcomes. There were no duplicate trial reports, and all but one were in English, and the Chinese report (Hu et al. 1997) being translated in English.

All 16 trials were randomised with a parallel group design and involved adults (aged 18 years or more) with plaque and gingivitis. In 13 of the studies, participants received a prophylaxis at the start of the study; in three studies (Lindhe et al. 1993, Triratana et al. 1993, 2002) no prophylaxis was undertaken prior to commencement. The participants in all studies were requested to use their allocated dentifrice twice a day but were unsupervised. In 15 trials plaque was scored using the Quigley–Hein plaque index (QHPI)and gingivitis by the Loe and Silness gingival index (LSGI). One study (Svatun et al. 1993) used the Silness and Loe plaque index and the Ainamo and Bay gingival bleeding index. Eleven trials reported the plaque severity index and 13 reported the gingivitis severity index.

Seven trials were performed in the USA, three in Thailand, two in Sweden and one in Spain, China, Norway and the Dominican Republic. Twelve studies were with two cells, three with four cells and one with three cells. All of the studies had the toothpaste provided by Colgate and 15 of the studies received commercial sponsorship.

Quality assessment of trials

Three criteria were used to assess the quality of the trial reports: random allocation, blinding of patients and examiner and the information provided on dropouts. All the trials were randomised, but the method of randomisation was unclear. Fifteen trials were double blind; one trial (Kanchanakamol et al. 1995) was single blind, with the control group using their usual toothpaste.

With the exception of one trial, all the dentifrices were supplied in plain white tubes. Drop-outs ranged from 1% to 13% and, when stated, were reported to be non-product related. No adverse events were reported.

The reviewers were in full agreement that the quality of all the trials was high.

Synthesis of data

The meta-analyses for both the QHPI and the plaque severity index showed that the triclosan/copolymer dentifrice is effective in reducing plaque compared with a fluoride dentifrice, with a weighted mean difference (WMD) of −0.48 (95% confidence interval (CI) (random effects): −0.64 to −0.32) for the QHPI (0–5 scale) and a WMD of −0.15 (95% CI (random effects): −0.20 to −0.09) for the plaque severity index (0–1 dichotomous index) (Fig. 1). There was significant heterogeneity between the studies that we are unable to explain in terms of clinical or methodological factors and a random effects model was, therefore, used to calculate the treatment effects.

Similarly, the meta-analyses for the Loe and Silness (0–3 scale) and gingivitis severity indices (0–1 dichotomous index) were both significant, showing a reduction in gingivitis when comparing the triclosan/copolymer dentifrice with a fluoride dentifrice, with WMDs −0.26 (95% CI (random effects): −0.34 to −0.18) and −0.12 (95% CI (random effects): −0.17 to −0.08), respectively (Fig. 2). Once again there

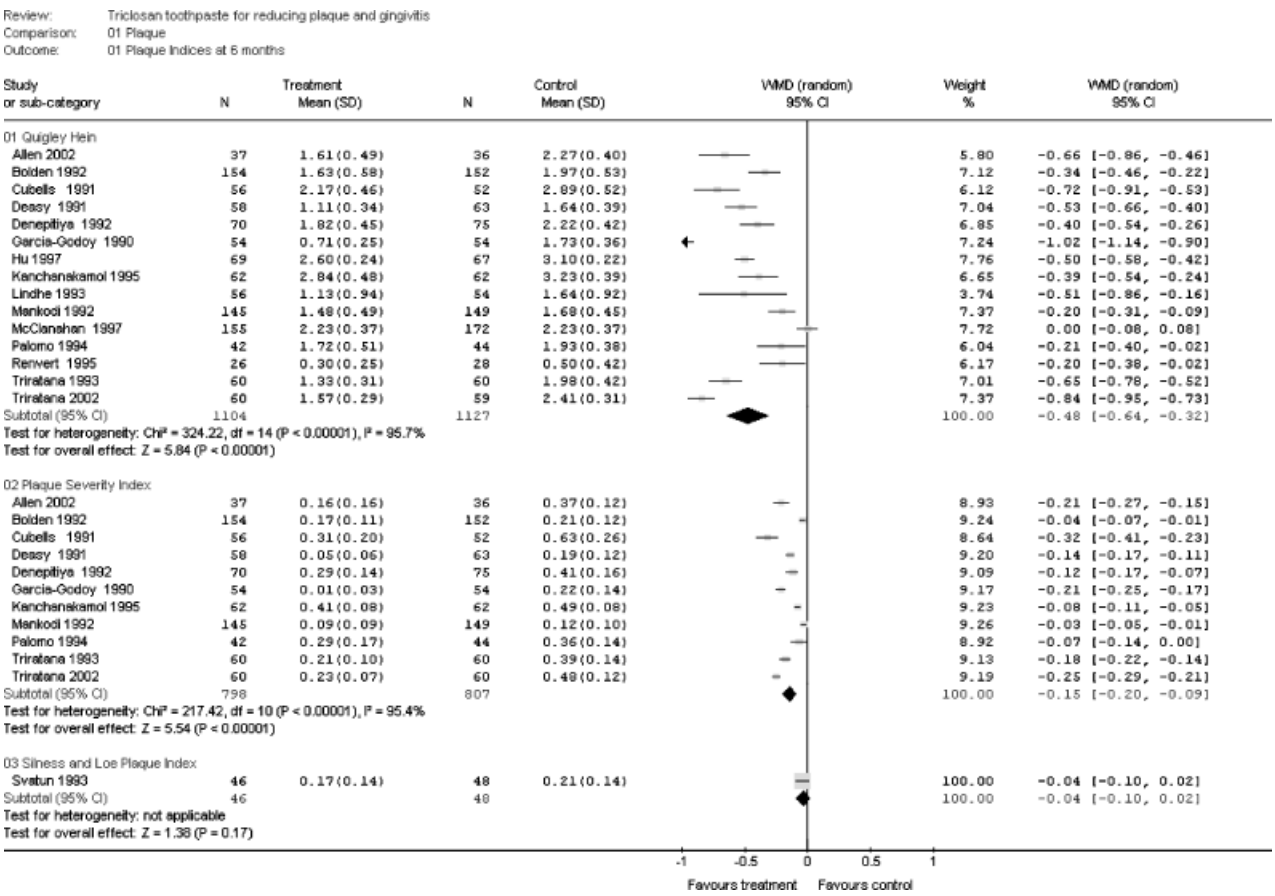

Fig. 1. Meta-analysis results for Quigley–Hein and plaque severity indices.

was significant heterogeneity and a random effects model was used.

The plaque and gingivitis severity indices demonstrated that the triclosan dentifrice reduced the proportion of surfaces with heavy plaque by 15% and those with gingival bleeding by 12%. In relative terms, the proportion of sites that had plaque reduced from 0.31 to 0.16, a 49% reduction. Similarly, the proportion of sites with bleeding reduced from 0.24 to 0.12, a 49% reduction. For the QHPI, the WMD corresponds to a 23% reduction in plaque when comparing the triclosan dentifrice with a fluoride dentifrice. For the LSGI, this also corresponds to 23% reduction.

To investigate publication and other biases, a funnel plot (plots of effect estimates versus the inverse of their standard errors) was drawn. Asymmetry of the funnel plot may indicate publication bias and other biases related to sample size, although it may also represent a true relationship between trial size and effect size. A formal investigation of the degree of asymmetry was performed using the method proposed by Egger et al (1997).Only one of the funnel plots of the trials for each of the plaque and gingivitis indices, gingivitis severity, appeared asymmetrical, and this was confirmed by the weighted regression test for asymmetry (Egger et al 1997) which was statistically significant for this index only (asymmetry intercept (95% CI): -6.83 (-12.10 to -1.55); $p = 0.016$). There is, therefore, some evidence of bias using this method.

Discussion

Despite the fact that most individuals claim to brush their teeth at least twice a day, the prevalence of gingivitis and chronic periodontitis remains high in most populations (Albandar 2002, Sheiham & Netuveli 2002). The maintenance of an effective level of plaque control is clearly difficult using conventional mechanical procedures and dentifrices (Morris et al. 2001) and yet, from a global perspective, it is the only realistic means of improving the periodontal health of communities and populations.

This systematic review assessed whether the addition of triclosan and a copolymer to a dentifrice improved the effectiveness of plaque control and gingival health. It is concluded that the unsupervised use of a dentifrice containing triclosan/copolymer significantly improved the removal of supragingival plaque and gingival health when compared with a fluoride dentifrice. The studies included were of at least 6 months duration as recommended by various bodies (Council on Dental Therapeutics 1986, Imrey et al. 1994, FDI Commission, 1999).

The presence of publication bias was investigated and there was evidence for this type of bias for one of the four outcomes reported, namely gingivitis severity. It is, therefore, unclear whether there is any publication bias in the reporting of these studies.

In 13 studies, the participants received a prophylaxis prior to commencing the study and indicates the

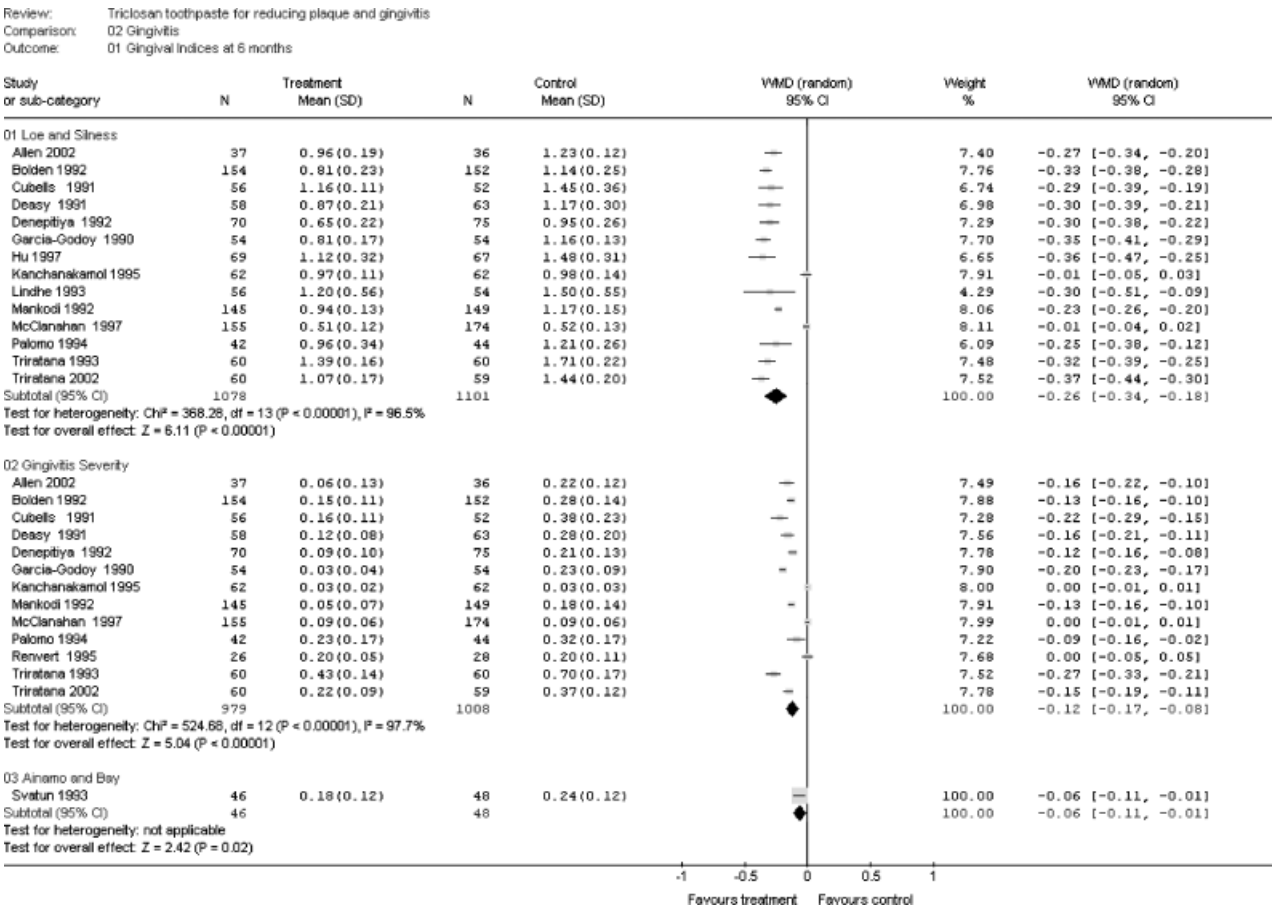

Fig. 2. Meta-analyses for Loe and Silness and gingivitis severity indices.

effectiveness of the dentifrices to control the subsequent accumulation of plaque. In the other three studies, no prophylaxis was provided and, therefore, indicates the effectiveness of the dentifrices in removing existing plaque and reducing further accumulation.

However, of greater clinical significance was the improvement in gingival health and reduction in gingival bleeding. While the progression of gingivitis to periodontitis is not a predictable event, bleeding sites are more likely to progress to periodontitis than non-bleeding sites (Lang et al. 1986). Three randomised-controlled trials of at least 3 years duration have demonstrated that the unsupervised use of tricosan/copolymer dentifrice significantly reduced the onset (Ellwood et al. 1998) and progression (Rosling et al. 1997, Cullinan et al. 2003) in susceptible individuals.

The studies included in the systematic review were conducted in seven countries and involved the unsupervised use of dentifrice in adults with existing plaque and gingival inflammation. Since the maintenance of an effective level of plaque control is an essential component of any programme designed to prevent and control periodontal disease, the findings may be generalisable to populations around the world.

In conclusion, this systematic review indicates that a dentifrice containing triclosan/copolymer provides a more effective level of plaque control and periodontal health than a conventional fluoride dentifrice.

References

Albandar, J. M. (2002) Periodontal diseases in North America. *Periodontology 2000* **29**, 31–69.

Allen, D. R., Battista, G. W., Petrone, D. M., Petrone, M. E., Chaknis, P., DeVizio, W. & Volpe, A. R. (2002) The clinical efficacy of Colgate Total Plus Whitening Toothpaste containing a special grade of silica and Colgate Total Fresh Stripe Toothpaste in the control of plaque and gingivitis: a six-month clinical study. *Journal of Clinical Dentistry* **13**, 59–64.

Bolden, T. E., Zambon, J. J., Sowinski, J., Ayad, F., McCool, J. J., Volpe, A. R. & DeVizio, W. (1992) The clinical effect of a dentifrice containing triclosan and a copolymer in a sodium fluoride/silica base on plaque formation and gingivitis: a six month clinical study. *Journal of Clinical Dentistry* **4**, 125–131.

Council on Dental Therapeutics (1986) Guidelines for acceptance of chemotherapeutic products for the control of supragingival dental plaque and gingivitis,. *Journal of the American Dental Association* **112**, 529–532.

Cubells, A. B., Dalmau, L. B., Petrone, M. E., Chaknis, P. & Volpe, A. R. (1991) The effect of a triclosan/copolymer dentifrice on plaque formation and gingivitis: a six-month clinical study. *Journal of Clinical Dentistry* **2**, 63–69.

Cullinan, M. P., Westerman, B., Hamlet, S. M., Faddy, M. J. & Seymour, G. J. (2003) The effect of a triclosan containing dentifrice on the progression of periodontal disease in an adult population. *Journal of Clinical Periodontology* **30**, 414–419.

Deasy, M. J., Singh, S. M., Rustogi, K. N., Petrone, D. M., Battista, G., Petrone, M. E. & Volpe, A. R. (1991) Effect of a dentifrice containing triclosan and a copolymer on plaque formation and gingivitis. *Clinical Preventive Dentistry* **13**, 12–19.

Denepitiya, J. L., Fine, D., Singh, S., DeVizio, W., Volpe, A. R. & Person, P. (1992) Effect upon plaque formation and gingivitis of a triclosan/copolymer /fluoride dentifrice: a six month clinical study. *American Journal of Dentistry* **5**, 307–311.

Drisko, C. H. (2001) Nonsurgical periodontal therapy. *Periodontology 2000* **25**, 77–88.

Egger, M., Davey-Smith, G., Schneider, M. & Minder, C. (1997) Bias in meta-analysis detected by a simple graphical test. *British Medical Journal* **315**, 629–634.

Ellwood, R. P., Worthington, H. V., Blinkhorn, A. S. B., Volpe, A. R. & Davies, R. M. (1998) Effect of a triclosan/copolymer dentifrice on the incidence of periodontal attachment loss in adolescents. *Journal of Clinical Periodontology* **25**, 363–367.

FDI Comission, Work Project (8–95). (1999) Guidance on the assessment of the efficacy of toothpastes. *International Dental Journal* **49**, 311–316.

Gaffar, A., Afflito, J., Nabi, N., Kruger, I. & Olsen, S. (1994) Recent advances in plaque, gingivitis, tartar and caries prevention technology. *International Dental Journal* **44** (Suppl. 1), 63–70.

Garcia-Godoy, F., Garcia-Godoy, F., DeVizio, W., Volpe, A. R., Ferlauto, R. J. & Miller, J. M. (1990) Effect of a triclosan/copolymer dentifrice on plaque formation and gingivitis: a 7 month study. *American Journal of Dentistry* **3**, S15–S26.

Hu, D., Zhang, J., Wan, H., Zhang, Y., Volpe, A. R. & Petrone, M. E. (1997) Efficacy of a triclosan/copolymer dentifrice in the control of plaque and gingivitis: a six-month study in the People's Republic of China [Chinese]. *Hua Xi Kou Qiang Yi Xue Za Zhi* **15**, 333–335.

Imrey, P., Chilton, N. W., Philstrom, B. L., Proskin, H. M., Kingman, A., Listgarten, M. A., Zimmerman, S. O., Ciancio, S. G., Cohen, M. E., D'Agostino, R. B., Fischman, S. L., Fleiss, J. L., Gunsolley, J. C., Kent, R. L., Killoy, W. J., Laster, L.L, Marks, R. G. & Varma, A. O. (1994) Recommended revisions to American Dental Association guidelines for the acceptance of chemotherapeutic products for gingivitis control. *Journal of Periodontal Research* **29**, 299–304.

Kanchanakamol, U., Umpriwan, R., Jotikasthira, N., Srisilapanan, P., Tuongratanaphan, S., Sholitkul, W. & Chat Uthai, T. (1995) Reduction of plaque formation and gingivitis by a dentifrice containing triclosan and copolymer. *Journal of Periodontology* **66**, 109–112.

Lang, N., Joss, A., Orsanic, T., Gusberti, F. A. & Siegrist, B. E. (1986) Bleeding on probing. A predictor for the progression of periodontal disease? *Journal of Clinical Periodontology* **13**, 590–596.

Lindhe, J., Rosling, B., Socransky, S. S. & Volpe, A. R. (1993) The effect of a triclosan-containing dentifrice on established plaque and gingivitis. *Journal of Clinical Periodontology* **20**, 327–334.

Mankodi, S., Walker, C., Conforti, N., DeVizio, W., McCool, J. J. & Volpe, A. R. (1992) Clinical effect of a triclosan- containing dentifrice on plaque and gingivitis: a six month study. *Clinical Preventive Dentistry* **14**, 4–10.

McClanahan, S. F., Beiswanger, B. B., Bartizek, R. D., Lanzalaco, A. C., Bacca, L. & White, D. J. (1997) A comparison of stabilized stannous fluoride dentifrice and triclosan/copolymer dentifrice for efficacy in the reduction of gingivitis and gingival bleeding: six-month clinical results. *Journal of Clinical Dentistry* **8**, 39–45.

Morris, A. J., Steele, J. & White, D. A. (2001) The oral cleanliness and periodontal health of UK adults in 1998. *British Dental Journal* **191**, 186–192.

Nabi, N., Mukerjee, C., Schmid, R. & Gaffar, A. (1989) In vitro and in vivo studies on triclosan/PVM/MA.copolymer/combination as an anti-plaque agent. *American Journal of Dentistry* **2**, 197–206.

Palomo, F., Wantland, L., Sanchez, A., Volpe, A. R., McCool, J. J. & DeVizio, W. (1994) The effect of three commercially available dentifrices containing triclosan on supragingival plaque formation and gingivitis: a six month study. *International Dental Journal* **44** (Suppl.), 75–81.

Renvert, S. & Birkhed, D. (1995) Comparison between 3 triclosan dentifrices on plaque, gingivitis and salivary microflora. *Journal of Clinical Periodontology* **22**, 63–70.

Rosling, B., Wannfors, B., Volpe, A. R., Furuichi, Y., Ramberg, P. & Lindhe, J. (1997) The use of a triclosan/copolymer dentifrice may retard the progression of periodontitis. *Journal of Clinical Periodontology* **24**, 873–880.

Sheiham, A. & Netuveli, G. S. (2002) Periodontal diseases in Europe. *Periodontology 2000* **29**, 104–121.

Svatun, B., Saxton, C. A., Huntington, E. & Cummins, D. (1993) The effects of three silica dentifrices containing Triclosan on supragingival plaque and calculus formation and on gingivitis. *International Dental Journal* **43**, 441–445.

Triratana, T., Rustogi, K. N., Volpe, A. R., DeVizio, W., Petrone, M. & Giniger, M. (2002) Clinical effect of a new liquid dentifrice containing triclosan/copolymer on existing plaque and gingivitis. *Journal of the American Dental Association* **133**, 219–225.

Triratana, T., Tuongratanaphan, S., Kraivaphan, P., Rustogi, K. N. & Volpe, A. R. (1993) The effect on established plaque formation and gingivitis of a triclosan/copolymer/fluoride dentifrice: a six month study. *Journal of the Dental Association of Thailand* **43**, 19–28.

Volpe, A. R., Petrone, M. E., DeVizio, W., Davies, R. M. & Proskin, H. M. (1996) A review of plaque, gingivitis, calculus and caries clinical efficacy studies with a fluoride dentifrice containing triclosan and PVM/MA copolymer. *Journal of Clinical Dentistry* **7** (Suppl.), S1–S14.

Address:
Robin M Davies
Dental Health Unit
Manchester Science Park
Lloyd Street North
Manchester M15 6SH
UK
Fax: +1 44 161 232 4700
E-mail: robin.davies@man.ac.uk