

A randomised, controlled clinical trial comparing chlorhexidine gel and low-dose fluoride toothpaste to prevent early childhood caries

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Objectives. This randomised, controlled trial compared the effectiveness of 0.12% chlorhexidine (CHX) gel and 304% fluoride toothpaste to prevent early childhood caries (ECC) in a birth cohort by 24 months.

Methods. The participants were randomised to receive either (i) twice daily toothbrushing with toothpaste and once daily 0.12% CHX gel ($n = 110$) or (ii) twice daily toothbrushing with toothpaste only (study controls) ($n = 89$). The primary outcome measured was caries incidence and the secondary outcome was percentage of children with mutans streptococci (MS). All mothers were

contacted by telephone at 6, 12, and 18 months. At 24 months, all children were examined at a community dental clinic.

Results. At 24 months, the caries prevalence was 5% (3/61) in the CHX and 7% (4/58) in the controls ($P = 0.7$). There were no differences in percentages of MS-positive children between the CHX and control groups (54% vs 53%). Only 20% applied the CHX gel once daily and 80% less than once daily.

Conclusions. Toothbrushing using 304% fluoride toothpaste with or without the application of chlorhexidine gel (0.12%) reduces ECC from 23% found in the general community to 5–7%. The lack of effect with chlorhexidine is likely to be due to low compliance.

Introduction

Prevention of early childhood caries (ECC) continues to be a challenge in many disadvantaged communities^{1–3}. Although early colonisation by mutans streptococci (MS) has been identified as a risk factor for ECC⁴, antimicrobial agents that are suitable for controlling cariogenic bacteria have not been extensively tested for preventing ECC. Fluoride varnish⁵ and povidone iodine⁶ have been shown to be effective in reducing ECC; however, as these agents require professional application, they are unsuitable for children who are not likely to visit professional practices.

Chlorhexidine (CHX) is a common oral antiseptic with effective bactericidal activity against mutans streptococci⁷, although it is much less active against lactobacilli (LB)⁸. Several studies have used CHX for ECC prevention with varying effectiveness depending on concentration, frequency of application and age of the participants. Although a 40% CHX varnish has been reported to reduce ECC⁹, it requires professional application. In contrast, gel preparations containing 0.2% or 1% CHX have shown promise in reducing MS in toddlers^{10,11} and can easily be applied by parents.

In Australia, low-dose fluoride dentifrices (<500 ppm fluoride) are routinely prescribed for preschool children to reduce the risk of fluorosis from ingestion of the pastes¹². In contrast to the 1000 ppm fluoride dentifrices, the anticaries effects of the low-dose fluoride

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pastes (<500 ppm) have not been demonstrated¹³. Although previous studies have shown that children who brush regularly have less ECC^{14,15} and that the commencement of toothbrushing can result in MS removal in 2-year-old children¹⁵, there are no randomised controlled trials that demonstrate the effects of low-dose fluoride (<500 ppm) dentifrices on ECC in toddlers.

We hypothesised that daily application of CHX from the time of tooth eruption would reduce MS colonisation and prevent ECC. Therefore, the present controlled trial aimed to investigate the efficacy of CHX in preventing ECC in a cohort of children who were monitored by telephone contacts at 6, 12, and 18 months and examined at 24 months. The primary outcome measured was the number of decayed teeth and the secondary outcome was MS presence.

Methods

This study was registered on the Australian Clinical Trial Registry (ACTRN 012606000 356561) and ethical clearance was obtained from Queensland Health and The University of Queensland. Signed informed consent was obtained from all mothers prior to commencement of the trial. The study was located at the Logan-Beaudesert district which is one of the most deprived areas in the state of Queensland, Australia¹⁶. A total of 234 mothers who attended community health facilities for birthing services between June 2007 and 2008 were approached for inclusion into this study. Consent was obtained from 199 mothers (85%).

Eligibility criteria for the study were healthy status and residence in the health service district of study. Children were randomised to receive either (i) once daily application of 0.12% CHX gel (Curasept®; Curaden Swiss, Saranno, Switzerland) as soon as the first teeth erupted, or (ii) no product (study control). The mothers of both CHX and study control groups were instructed to brush twice daily with a smear of low-dose fluoride dentifrice (304% fluoride) on a child's toothbrush (My First Toothpaste®; Colgate Oral Care, Sydney, NSW, Australia) as soon as the

first teeth emerged. Randomisation into the CHX or control groups was performed at recruitment by every mother selecting a colour-coded stick out of an opaque bag (allocation ratio 1 : 1).

Telephone contacts were made to the mothers at ages of approximately 6, 12, and 18 months by oral health therapists. These University-trained dental practitioners have core skills in paediatric dentistry, dental hygiene, and health promotion. The six oral health therapists involved in the study underwent training for the research procedures and adhered strictly to a standardised protocol to ensure consistency of instruction and oral health education for both CHX and control groups.

At each telephone contact, which lasted approximately 20 min, a validated questionnaire on the child's social, medical, dental and feeding histories, and oral hygiene habits was administered¹⁴. The mothers in the CHX group were instructed to apply a pea-sized amount of the CHX gel on a clean index finger and smear it evenly on the child's teeth after the evening toothbrushing.

At the 12 and 18 months contacts, the mothers were also questioned on their compliance with toothbrushing and use of CHX and occurrence of adverse events. Compliance was assessed by the frequency of toothbrushing and application of CHX gel. General oral health education including feeding and dietary advice was also given. Free toothbrushes, CHX pastes, and tubes of low-dose fluoride dentifrice were mailed to the mothers after completion of the first telephone contact at 6 months and again at 12 and 18 months.

Sample size

To detect a difference in dmft (decayed, missing or filled teeth) of 5% in the treatment group and 22% in the control group with 80% power required 49 children per group. This is based on using a Chi-squared test with a two-sided 5% significance level. To compensate for an expected 25% drop-out per year, we increased the target sample size to 90 each in the CHX and control groups (180 in total)¹⁷.

Dental examination

All children attended the community dental clinic for a dental examination at 24 months of age. The examinations were conducted in the community dental clinic by seven calibrated examiners who were blinded to the treatment received. These examiners were calibrated prior to the commencement of study. High quality colour photographs were employed for inter- and intra-examiner testing as it is difficult to perform repeat examinations of toddlers by multiple operators. For this test, we used colour photographs showing a total of 290 teeth in the mandibular and maxillary arches of 17 children with ECC. The charting of the teeth was repeated twice and results compared to determine inter- and intra-examiner variability. The mean kappa statistics from the intra- and inter-examiner variability tests for the examination of carious lesions were 0.91 and 0.86 which indicated high consistency¹⁷. The teeth were examined for carious cavitations and precavitated white spot lesions¹⁸. These were recorded at tooth levels¹⁸.

Microbiological analysis

Microbial samples were obtained from each child and mother by lightly rubbing all teeth surfaces with sterile cotton-tipped swabs¹⁴. The oral swabs were immediately spread across the surfaces of the Mitis-Salivarius-Bacitracin and the Rogosa agar strips provided in a commercial microbiological kit (CRT Strep mutans test kit®; Ivoclar Vivadent, Schaan, Liechtenstein) to assess MS and LB counts¹⁹. The culture tubes were incubated within a few hours at 37°C for 48 h, and bacterial growth assessed using the manufacturer's reference charts by one of three calibrated researchers whose mean kappa statistic for inter-examiner consistency was 0.93.

Statistical analysis

A biostatistician on our team (AGB) supervised the study design and statistical analysis. Data were analysed using the SPSS statistical software program (version 18; IBM, Chicago, IL, USA). Chi-square test and student's *t*-test

were used for statistical analysis. An intent-to-treat strategy was used and the children's results analysed according to their assigned treatment group. In addition, to determine whether the results varied with compliance, we also analysed the results stratifying for mothers' compliance with treatment. As the groups were randomised, no potential confounders were controlled for the CHX and study control group. Comparability between the CHX and study controls was checked at 24 months.

Results

The randomisation of the groups resulted in comparable groups with regard to socio-demographic and caries-risk variables (Table 1). Figure 1 shows the results of the study and attrition rates at 6, 12, 18, and 24 months. At the examination visit at 24 months, there were no statistically significant differences in retention rates for the CHX (55%) and study controls (65%). The main reasons for drop-out from both groups were inability to contact the mother, and her relocation beyond a reasonable distance from the research centre (Table 2).

At 24-months, the caries prevalence was 5% (3 of 61) in the CHX group, and 7% (4 of 58) in the controls. These differences were not statistically significant ($P = 0.7$) (Fig. 1). There were also no statistically significant differences in the mean number of carious teeth per child with caries (Fig. 1). All the caries lesions detected at 24 months were frank cavitations. There were no white spot precavitated lesions. The percentage of children brushing twice daily in the CHX group (80%) was significantly higher compared with the study controls (67%, $P < 0.001$) (Table 2). There were no differences in antibiotic intake between the groups.

Stratifying by toothbrushing frequencies did not reveal any significant differences in caries rates and percentages of MS-positive children among the groups. Hence, for further analysis, the children were grouped according to compliance with CHX. There were 12 of 61 (20%) children whose mothers were compliant in applying the CHX once daily and 49 of

Table 1. Characteristics of mothers and children at baseline.

	Chlorhexidine (CHX)		Study controls (SC)		CHX versus SC <i>P</i> value
	<i>n</i>	Mean $\pm$ SD	<i>n</i>	Mean $\pm$ SD	
Child's age (days)	110	6 $\pm$ 9	89	10 $\pm$ 22	0.08
Mother's age at child's birth (years)		27 $\pm$ 6		27 $\pm$ 6	>0.99
Child birth weight (kg)		3.4 $\pm$ 0.6		3.5 $\pm$ 0.6	0.24
Gestational age (weeks)		39.3 $\pm$ 1.7		39.5 $\pm$ 1.5	0.39
	<i>n</i>	%	<i>n</i>	%	
Sex					
Male	57	52	45	51	0.92
Female	53	48	43	49	
Missing			1		
First child in family					0.98
Yes	41	45	30	45	
No	51	55	37	55	
Missing	18		22		
Mother born in Australia					0.99
Yes	66	72	49	73	
No	26	28	18	27	
Missing	18		22		
Main language spoken at home					0.57
English	83	90	63	94	
Not english	9	10	4	6	
Missing	18		22		
Mother's highest education level					0.94
Primary	0		0		
High	54	59	38	57	
Technical college	26	28	19	28	
Tertiary	12	13	10	15	
Missing	18		22		
Mother with dental cavitations at baseline					0.34
Yes	27	25	16	18	
No	83	76	73	82	
Mother's birth MS count					0.30
0	13	16	19	21	
<10 ⁵	47	57	40	45	
>10 ⁵	23	28	30	34	
Missing	27				
Mother's birth LB count					0.63
0	35	42	32	36	
<10 ⁵	40	48	47	53	
>10 ⁵	8	10	10	11	
Missing	27				

61 (80%) children who were noncompliant (less than once daily). Table 3 shows the prevalence of MS and LB in the controls and the fully compliant (applying CHX once daily) and less compliant (applying CHX less than once daily) groups. There were no statistically significant differences in percentages of children with MS or LB between the CHX and controls ($P = 0.2$ and $P = 0.1$ respectively) (Table 3). It is, however, interesting to note that the fully compliant CHX group did not have children with MS and LB counts

>10⁵ CFU/mL. No adverse effects, including dental staining, were recorded in any of the children.

Discussion

The state of Queensland in Australia has one of the highest caries rates in the country, with prevalence rates in 4-year-olds reported as 34% in 2000 and 37% in 2005^{20,21}. In areas of high social disadvantage, such as the Logan-Beaudesert district (location of this

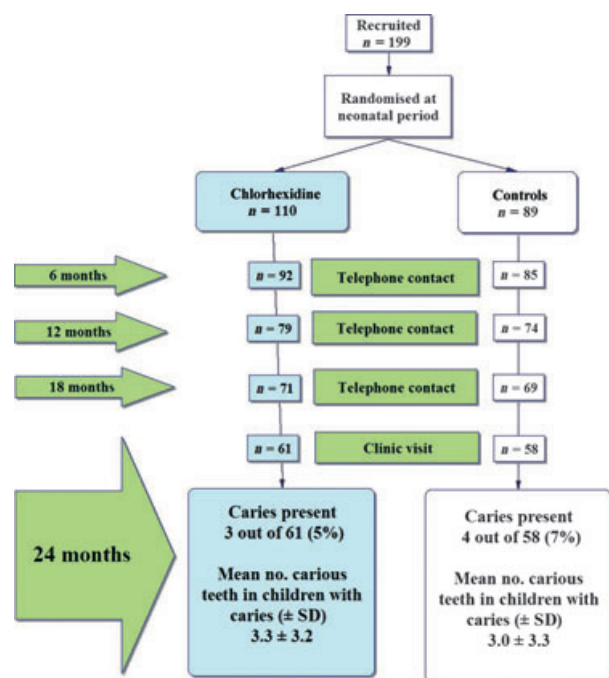


Fig. 1. Caries rates at 24 months in the chlorhexidine and control groups.

study), the caries prevalence is expected to be even higher¹⁶. In a study conducted in parallel with the present investigation, we reported that 23% of children aged 24 months, who were randomly recruited from child care facilities in the same community showed ECC²². Therefore, the low caries rates of 5 and 7% that were observed in the CHX and control groups in this study are remarkable and unexpected for a high-risk community.

The low ECC rates are most likely the result of the telephone contacts with oral health professionals which increased the mothers' motivation to follow toothbrushing instructions and dietary advice. As all the mothers in this study (both CHX and study controls) received telephone calls at 6, 12, and 18 months, it is possible that a maximum effect for caries reduction had resulted from these telephone calls so that further decreases in caries resulting from CHX are difficult to obtain. This effect was demonstrated in our previous study comparing home visits with telephone contacts, in which we reported that both types of contact can help motivate mothers to perform toothbrushing and other dental health promoting behaviours²². That study demonstrated that although both home

visits and telephone contacts are effective in reducing early childhood caries, the personal dental health advice and toothbrushing instruction which are delivered individually through home visits appeared to have a greater effect compared with telephone contacts in reducing ECC²².

The oral health therapists employed in this study are highly skilled in health promotion and the mothers are likely to have been motivated by them to perform the toothbrushing as instructed over the telephone. It is possible that the toothbrushing alone had resulted in such high levels of caries prevention that any additional effects of CHX were not apparent; however, the contribution of the low levels of fluoride (304%) present in the dentifrice is unclear as most studies have reported that low-dose fluoride pastes are not efficacious for caries prevention²³. Thus, it is possible that the caries-preventing effect stem largely from the physical removal of plaque rather than from the effects of fluoride.

A limitation of this study is the difficulty of maintaining telephone contact with families in this itinerant community. Inability to contact mothers and relocation beyond a reasonable distance from the research centre were the main reasons for drop-out; however, the drop-out rate per year of approximately 20% are comparable with those of other studies in similar communities⁵. The drop-out rates were similar in both CHX and control groups and it is possible that the low caries prevalence in both groups at 24 months may have resulted from the fact that those children who dropped out were the high-risk participants.

Also, only approximately 20% of the children applied the CHX gel on a daily basis as instructed, and the lack of compliance may have limited the effectiveness of the gel. Furthermore, the apparent lack of effect of CHX may be related to the fact that the gel was not applied evenly on the teeth, and this may have resulted in reduced effectiveness. As shown by Sandham and co-workers, the covering all tooth surfaces during application of CHX was more effective in reducing MS compared to partial covering of selected surfaces²⁴.

Table 2. Characteristics of mothers and children at 24 months.

	Chlorhexidine (CHX)		Study control (SC)		CHX versus SC <i>P</i> value
	<i>n</i>	Mean $\pm$ SD	<i>n</i>	Mean $\pm$ SD	
Child age (months)	61	25 $\pm$ 2	58	26 $\pm$ 2	0.73
Mother's age at child's birth (years)		28 $\pm$ 7		27 $\pm$ 6	0.41
Child birth weight (kg)		3.3 $\pm$ 0.6		3.6 $\pm$ 0.6	0.007*
Gestational age (weeks)		39.3 $\pm$ 1.7		39.6 $\pm$ 1.4	0.30
	<i>n</i>	(%)	<i>n</i>	(%)	
Mother born in Australia					
Yes	42	71	44	76	0.72
No	17	29	14	24	
Missing	2		0		
Main language spoken at home					
English	52	88	54	93	0.55
Not english	7	12	4	7	
Missing	2		0		
Mother's highest education level					
Primary †	0		0		0.46
High †	26	44	30	52	
Technical college	24	41	18	31	
Tertiary	9	15	10	17	
Missing	2		0		
Sex					
Male	36	59	31	53	0.67
Female	25	41	27	47	
First child in family					
Yes	26	44	27	47	0.93
No	33	56	31	53	
Missing	2		0		
Toothbrushing frequency					
2/day	48	80	39	67	<0.001
<2/day	12	20	19	33	
Missing	1		0		
Snack Frequency					
3+	16	27	17	29	0.84
2–3	39	66	38	66	
<2	4	7	3	5	
Missing	2				
Drop-out‡	49	44	31	35	0.21

*Not likely to be of clinical significance, as all children were within the normal birth weight range.

†Combined for analysis.

‡Main reason for drop-out was inability to contact and relocation beyond a reasonable distance from the research centre.

In this randomised clinical trial, we used an intent-to-treat approach, which means that subjects with a low compliance of CHX were not excluded. This gives a better estimate of the treatment effect when used in real life. Therefore, although the compliance is low, it does not invalidate our study. Rather the low compliance is part of the reason why chlorhexidine was not effective.

Although a slightly greater percentage of children brushed their teeth twice daily in the CHX group compared with the control

group, the results showed that outcomes were not affected. Also, although community water fluoridation was introduced into Queensland's water supply approximately 18 months after commencement of the study, all the children in the study were recruited before the introduction of water fluoridation. All children in the study would have been exposed to the same extent of water fluoridation, so the introduction of fluoridation into the community water supplies should not be a confounding factor. No adverse effects with

Table 3. Prevalence of children with mutans streptococci (MS) and lactobacilli (LB) at 24 months, stratified by frequency of chlorhexidine (CHX) application.

Group <i>N</i> (%)	Absence <i>N</i> (%)	Presence <i>N</i> (%)	<10 ⁵ CFU/mL <i>N</i> (%)	>10 ⁵ CFU/mL	Total <i>N</i>
Mutans streptococci*					
CHX (All)	33 (54)	28 (46)	22 (36)	6 (10)	61
CHX 1/day	9 (75)	3 (25)	3 (25)	0 (0)	12
CHX <1/day	24 (49)	25 (51)	19 (39)	6 (12)	49
Controls	31 (53)	27 (47)	17 (29)	10 (17)	58
Lactobacilli**					
CHX (All)	67 (37)	116 (63)	81 (44)	35 (19)	183
CHX 1/day	3 (25)	9 (75)	9 (75)	0 (0)	12
CHX <1/day	8 (16)	41 (84)	24 (49)	17 (35)	49
Controls	20 (34)	38 (66)	24 (41)	14 (24)	58

*Percentages of children with MS present were not significantly different between CHX and controls ($P = 0.2$). Also, there were no differences between the groups who applied CHX once daily and those who applied less than once daily.

**Percentages of children with LB present were not significantly different between the CHX groups and controls ($P = 0.1$). There were no differences between the groups who applied CHX once daily and those who applied less than once daily.

CHX were reported in this study. Staining of the teeth, which is occasionally associated with CHX, was not encountered, probably due to the antistaining formulation of the CHX paste used in this study; however, minimal information is currently available regarding the effects on the ecology and evolution of the microbial oral flora as well as the toxicological aspects in relation to oral use of CHX in young children. Furthermore, it is unclear whether ingested CHX has any effects on the intestinal flora.

The present results can be substantiated by previous studies which demonstrated that CHX application decreases MS counts to low levels in plaque and saliva²⁵. In an investigation on toddler children, Twetman and Grindejord reported that twice daily brushing with 1% CHX resulted in significant reduction in MS counts which was still evident a month after cessation¹¹. In similar-aged cohorts of children, we previously demonstrated that MS colonisation and caries prevalence can be reduced by once daily 0.2% CHX gel applications^{10,26,27}. Other authors have also reported that 6 monthly applications of 40% CHX varnish resulted in significant caries reduction in 4–5-year-old children⁹.

Our present results also extend those of previous studies which showed that professional telephone contacts with mothers during early childhood can reduce the incidence of ECC^{28,29}, or risk factors for ECC³⁰. In

disadvantaged communities, however, it is often difficult to maintain regular telephone contact as many high-risk families change residence frequently, and this method of health promotion may be limited to mothers who have more stable living arrangements.

In conclusion, this study demonstrates that regular toothbrushing with 304% fluoride toothpaste reduces caries from 23% in the community to 7%. The additional use of CHX gel (0.12%) does not increase its effectiveness by 24 months. Furthermore, given the costs involved, the use of CHX cannot be recommended. We will continue to monitor the children to determine the long-term effects of the interventions.

Why this paper is of interest to paediatric dentists

- This study demonstrates that daily application of chlorhexidine (0.12% gel) did not give additional benefits over twice daily toothbrushing with low-dose fluoride (304%) children's toothpaste in reducing early childhood caries.

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Conflicts of interest

The authors declare no conflicts of interest in the study.

References

- 1 Bissar AR, Schulte AG, Muhjazi G, Koch MJ. Caries prevalence in 11–14-year old migrant children in Germany. *Int J Public Health* 2007; **52**: 103–108.
- 2 Davies GM, Duxbury JT, Boothman NJ, Davies RM. Challenges associated with the evaluation of a dental health promotion programme in a deprived urban area. *Community Dent Health* 2007; **24**: 117–121.
- 3 Douglass JM, O'Sullivan DM, Tinanoff N. Temporal changes in dental caries levels and patterns in a Native American preschool population. *J Pub Health Dent* 1996; **56**: 171–175.
- 4 Alaluusua S, Renkonen OV. Streptococcus mutans establishment and dental caries experience in children from 2 to 4 years old. *Scand J Dent Res* 1983; **91**: 453–457.
- 5 Weintraub JA, Ramos-Gomez F, Jue B *et al.* Fluoride varnish efficacy in preventing early childhood caries. *J Dent Res* 2006; **85**: 172–176.
- 6 Lopez L, Berkowitz R, Spiekerman C, Weinstein P. Topical antimicrobial therapy in the prevention of early childhood caries: a follow-up report. *Pediatr Dent* 2002; **24**: 204–206.
- 7 Emilson CG. Potential efficacy of chlorhexidine against mutans streptococci and human dental caries. *J Dent Res* 1994; **73**: 682–691.
- 8 Featherstone JDB. Delivery challenges for fluoride, chlorhexidine and xylitol. *BMC Oral Health* 2006; **6**(Suppl 1): S8.
- 9 Du MQ, Tai BJ, Jiang H, Lo ECM, Fan MW, Bian Z. A 2-year randomized clinical trial of chlorhexidine varnish on dental caries in Chinese preschool children. *J Dent Res* 2006; **85**: 557–559.
- 10 Wan AKL, Seow WK, Purdie DM, Bird PS, Walsh LJ, Tudehope DI. The effects of chlorhexidine gel on Streptococcus mutans infection in 10-month-old infants: a longitudinal, placebo-controlled, double-blind trial. *Pediatr Dent* 2003; **25**: 215–222.
- 11 Twetman S, Grindejford M. Mutans streptococci suppression by chlorhexidine gel in toddlers. *Am J Dent* 1999; **12**: 89–91.
- 12 Australian Dental Association. Community oral health promotion- fluoride use. ADA policy statement 2.2.1. 2010:1–6.
- 13 Wong MC, Glenny A-M, Tsang BW, Lo EC, Worthington HV, Marinho VC. Topical fluoride as a cause of dental fluorosis in children. *Cochrane Database Syst Rev* 2010; **6**: CD007693.
- 14 Seow WK, Clifford H, Battistutta D, Morawska A, Holcombe T. Case-control study of early childhood caries in Australia. *Caries Res* 2009; **43**: 25–35.
- 15 Seow WK, Cheng E, Wan V. Effects of oral health education and tooth-brushing on mutans streptococci infection in young children. *Pediatr Dent* 2003; **25**: 223–228.
- 16 Public Health Information Development Unit Australia. *Population Health Profile of the Logan Area Division of General Practice: Supplement*. Public Health Information Development Unit (No. 70). Adelaide: Commonwealth of Australia, 2007.
- 17 Fleiss JL. *Statistical Methods for Rates and Proportions*. New York: John Wiley & Sons, 1981.
- 18 Drury TF, Horowitz AM, Ismail AI, Maertens MP, Rozier RG, Selwitz RH. Diagnosing and reporting early childhood caries for research purposes. A report of a workshop sponsored by the National Institute of Dental and Craniofacial Research, the Health Resources and Services Administration, and the Health Care Financing Administration. *J Pub Health Dent* 1999; **59**: 192–197.
- 19 Tanabe Y, Park JH, Tinanoff N, Turng BF, Lilli H, Minah GE. Comparison of chairside microbiological screening systems and conventional selective media in children with and without visible dental caries. *Pediatr Dent* 2006; **28**: 363–368.
- 20 Armfield J, Roberts-Thomson K, Spencer AJ, Slade G. *The Child Dental Health Survey 2000*. Canberra, Australia: Australian Institute of Health and Welfare, 2004.
- 21 Ha DH, Roberts-Thomson KF, Armfield JM. *The Child Dental Health Surveys, Australia 2005 and 2006*. Canberra, Australia: Australian Institute of Health and Welfare, 2011.
- 22 Plonka K, Pukallus M, Barnett A, Holcombe T, Walsh LJ, Seow WK. A controlled longitudinal study of home visits compared to telephone contacts to prevent early childhood caries. *Int J Paediatr Dent* 2012; Published online: DOI: 10.1111/j.1365-263X.2011.01219.
- 23 Ammari AB, Bloch-Zupan A, Ashley PF. Systematic review of studies comparing the anti-caries efficacy of children's toothpaste containing 600 ppm of fluoride or less with high fluoride toothpastes of 1000 ppm or above. *Caries Res* 2003; **37**: 85–92.
- 24 Sandham HJ, Brown J, Chan KH, Phillips HI, Burgess RC, Stokl AJ. Clinical trial in adults of an antimicrobial varnish for reducing mutans streptococci. *J Dent Res* 1991; **70**: 1401–1408.
- 25 Ostela I, Tenovuo J. Antibacterial activity of dental gels containing combinations of amine fluoride, stannous fluoride, and chlorhexidine against cariogenic bacteria. *Scand J Dent Res* 1990; **98**: 1–7.

- 26 Law V, Seow WK. A longitudinal controlled study of factors associated with mutans streptococci infection and caries lesion initiation in children 21–72 months old. *Pediatr Dent* 2006; **28**: 58–65.
- 27 Law V, Seow WK. A longitudinal study of 0.2% chlorhexidine gel for removal of mutans streptococci infection in preschool children. *Aust Dent J* 2007; **52**: 26–32.
- 28 Weinstein P, Harrison R, Benton T. Motivating mothers to prevent caries: confirming the beneficial effect of counseling. *J Am Dent Assoc* 2006; **137**: 789–793.
- 29 Plutzer K, Spencer AJ. Efficacy of an oral health promotion intervention in the prevention of early childhood caries. *Community Dent Oral Epidemiol* 2008; **36**: 335–346.
- 30 Freudenthal JJ, Bowen DM. Motivational interviewing to decrease parental risk-related behaviors for early childhood caries. *J Dent Hygiene* 2010; **84**: 29–34.

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