Caries prevention for older people in residential care homes

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When attempting to prevent dental caries in older people who live in residential care homes, what is the effectiveness and relative cost benefit of high concentration fluoride toothpaste compared with fluoride varnish application?

Clinical scenario

A dentist who is involved in oral health promotion is aware that dental caries is becoming more prevalent in an increasingly elderly population.¹ He also knows that institutionalised elderly are an under-served group in terms of preventive oral health care.^{2,3} He would like to improve the oral health of elderly residents of long-term care homes in the area where he works, in which water fluoride concentration is <0.15 ppm.

The two interventions of interest to him are daily use of toothpaste containing a higher fluoride concentration than in normal paste for adults, and professionally applied fluoride varnish. His knowledge and understanding of caries, fluoride and the environment in which he would like to effect a change, lead him to postulate that these interventions might result in reduction of caries and subsequent development of dental pain and abscesses for the residents. He is uncertain, however, of the extent of any possible benefit and also whether using toothpaste with >1450 ppm fluoride would have a greater caries-protective effect than a fluoride varnish with 22,600 ppm fluoride. The dentist also wants to be able to discuss the relative cost of these two options, should they show any clinical effectiveness, when he presents his proposed caries-preventive programme for adoption. He decides to appraise the evidence for these questions by undertaking a literature review.

Clinical question

The following two clinical questions and their PICO (person/ intervention/ comparison/ outcome) questions were developed:

In elderly people who live in care homes (person), does the use of a) a high concentration (>1450 ppm fluoride) toothpaste (intervention) compared with standard concentration (1000–1450 ppm fluoride) toothpaste

Table 1. Search strategy*

Search	Search term	Result
1	caries AND NOT children	25,334
2	elderly OR gerondont* OR aged OR geriatric	2,816,726
3	fluoride	95,087
4	1 and 2 and 3	327
5	Limit to: medicine and dentistry	287
6	Limit to articles and reviews	268
7	Limit to English	250

*Scopus (1960 to date) was searched; last updated August 2009 (www.scopus.com/scopus/).

(comparison) or b) the use of biannual application of 22,600 ppm fluoride varnish (intervention) compared with no application of fluoride varnish (comparison), result in improved dental/ oral health (outcome) as measured by a reduction in caries experience, pain/ sepsis, improved aesthetics, and oral function?

What is the relative cost of each of these interventions?

Search strategy

The search strategy was based around the following key words:

- Dental caries, root caries, caries prevention, intervention programs
- Adult (population), elderly (population), aged, aged 80 and older, frail elderly, geriatric (population), gerodontology
- Long-term care facility, institutionalised/ institutionalized, care homes
- Toothpaste, topical fluorides, dentifrice, fluoride, fluoride gel, fluoride rinse, fluoride varnish, varnish, oral hygiene, professional tooth cleaning

Document types: clinical trials and reviews

All retrieved articles' titles were checked for relevance, and abstracts read where

appropriate. If thought to be relevant, the papers were gathered and read. Six papers were considered appropriate and were subsequently appraised.

Additional searches for grey sources of information were carried out using CrossSearch and the Networked Digital Library of Theses and Dissertations. This revealed a recent PhD thesis from the University of Hong Kong which proved to be relevant but did not seem to have yielded any published papers as yet. The data were considered appropriate for inclusion in the review, as the complete thesis could be accessed and, having been passed at doctorate level, would have been peer reviewed.

Discussion

The vast majority of investigations for fluoride interventions to reduce dental caries have been conducted in children. Systematic reviews of these have unequivocally proven the effectiveness of topical fluoride in preventing/ arresting caries.^{10–13} There are few studies in the adult or elderly population, however. One systematic review confirmed that fluoride is an effective caries preventive measure in adults of all ages¹⁴ and a recent review of the effectiveness of fluoride

interventions for prevention of root caries in adults found that regular topical fluoride was beneficial in reducing root caries.¹⁵

The dose–response relationship between fluoride concentration in toothpastes and reduction in dental caries was first reported in 1973 when it was shown that 1000 ppm fluoride was more effective at reducing caries experience¹⁶ than 250 and 500 ppm fluoride. Since then, there have been many studies which have shown a positive relationship between fluoride concentration in dentifrices and other preparations (including mouthwashes and gel applications) and reduction in caries experience. Findings from the studies vary, but there is a consistent overall picture that higher fluoride levels have greater anticaries effects than lower fluoride levels. Again, most studies have been carried out in children. The few available studies of high fluoride concentration dentifrices (in excess of 2000 ppm fluoride), continue to support a linear dose–response relationship.¹⁷ An elderly population in a care facility presents a different group for a number of reasons including: less efficient metabolism, frequent health problems, polypharmacy, old teeth, established caries lesions, root caries, and an often limited ability to carry out oral healthcare themselves. This means that care must be taken when extrapolating the data from studies on children.

Six studies were identified that were relevant to the clinical question being asked and although not all were confined to elderly persons in residential care, all were in adults. Three of the studies compared high strength fluoride toothpaste (5000 ppm fluoride) to standard strength toothpaste (1000 ppm to 1450 ppm fluoride). Two compared fluoride varnish (22,600 ppm fluoride) with standard toothpaste and one compared both high strength toothpaste and fluoride varnish with standard toothpaste. There are two main high strength toothpastes available in the UK (Duraphat 5000 ppm fluoride and Duraphat 2800 ppm fluoride; Colgate-Palmolive UK Ltd). No studies were found that had been carried out in adults using 2800 ppm fluoride toothpaste.

Although a variety of outcome measures were reported, all four toothpaste studies^{4–7} consistently found an improved response for caries control with the high strength fluoride toothpaste compared with standard

toothpaste. This supports the dose-related response that is reported in the literature.¹⁷ No studies investigated what might be considered more patient-relevant factors such as aesthetics and oral function.

Three well-controlled randomised control trials compared fluoride varnish at 22,600 ppm fluoride (Duraphat varnish) with normal adult strength toothpaste (1000 ppm to 1450 ppm).^{7–9} All three studies reported an improved response for caries control with the varnish compared with the normal toothpaste (this was even the case in the one study⁹ that also included oral hygiene instruction in the control arm).

The effect of a high strength self-administered fluoride toothpaste (5000 ppm fluoride) and monthly hygienist applications of 22,600 ppm fluoride varnish were only directly compared in one study.⁷ Both interventions were found to be more effective at controlling root caries than brushing with 1450 ppm fluoride toothpaste alone, but that there was no difference in the outcomes between the interventions. The 22,600 ppm fluoride varnish and the 5000 ppm fluoride toothpastes were equally effective but an additional basic cost analysis of the two interventions was carried out, which showed that the fluoride varnish was over 30-fold more expensive to provide, because of the cost of the hygienist.

For residents in care homes, there are additional considerations regarding potential excessive ingestion of fluoride. For adults, there are no UK recommendations on safe fluoride ingestion levels, but in the National Electronic Library for Medicines (www.nelm.nhs.uk) safe levels are taken from the a US committee (US Standing Committee on the Scientific Evaluation of Dietary Reference Intakes of the Food and Nutrition Board) that recommends that the tolerable upper limit for fluoride is 10 mg a day for an adult. Older people, however, are more likely to have low body mass and to be frail. For residents in the area, drinking 1.5 litres a day of 0.15 ppm-fluoride-containing water would give a dietary intake of 0.225 mg fluoride per day. In addition, they may drink large quantities of tea, especially if living in the warm, dry atmosphere of a care home. Tea can contain around 3 ppm fluoride, so if brewed from 0.15 ppm fluoride water, drinking a litre a day of tea as a part of their 1.5 litres a day of fluids would give a total daily intake of 3.23 mg

fluoride per day. One gram of Duraphat 5000 ppm fluoride paste will contain 5 mg fluoride, and it is conceivable that an older person might swallow more excess paste than younger people, because of poor oral function or confusion. In addition, high turnover of staff is a fact of life in many care homes, so supervision of twice daily brushing might be less than adequate. It is also not an unlikely scenario that, given the high staff turnover in some long-term care homes, and the fact that the Duraphat 5000 ppm fluoride paste looks like a standard toothpaste, it might be used as such, in error. This would mean a full toothbrush of paste could be ingested in a frail elderly person twice a day. It would seem prudent, therefore, to recommend 2800 ppm fluoride paste for this population.

From a safety point of view, the use of Duraphat (22,600 ppm fluoride) varnish according to the manufacturer's instructions should not pose a toxicity hazard, and could be used on a 3-monthly basis as there is no risk of fluorosis in this population. It is an expensive product, though, and as it requires professional application, would be costly to apply.

In summary, there is good evidence that 22,000 ppm fluoride varnish and 5000 ppm fluoride toothpaste are likely to be effective at reducing caries in an elderly population that is resident in care homes, in an area of low water fluoridation. With concerns regarding potential fluoride toxicity because of low body mass, poor oral function, uncertainty over level of supervision to avoid ingestion, and the quantity of daily fluid intake consumed as tea, it would seem prudent to recommend the use of 2800 ppm fluoride paste, rather than the 5000 ppm fluoride paste. The professional application of 22,600 ppm fluoride varnish three times a year could give additional benefit.

Clinical bottom line

For elderly populations in residential care, in areas with low levels of fluoride in drinking water, who are assessed as being at increased risk of dental caries:

- Toothbrushing carried out twice daily with a 2800 ppm fluoride paste, following the manufacturer's instructions regarding quantity, is likely to give improved caries control over standard toothpaste while avoiding any risk of toxicity.

Table 2. Summary of relevant papers

Paper, date and setting	Study details	Key results	Conclusion	Weaknesses
Studies relevant to high-strength fluoride dentifrices				
1) Baysan A, <i>et al.</i> (2001) ⁴ Setting: dental hospital, England, UK	Design: double blind RCT of high strength toothpaste (5000 ppm F) vs 1100 ppm F standard adult strength toothpaste; looked at the effect of each on reversing root caries. Person 201 subjects (age range, 27–90 years; mean 59 years) with root caries lesions Intervention High strength toothpaste (5000 ppm F used ≥once daily Comparison 1100 ppm F standard adult strength toothpaste used ≥once daily Outcomes 1. Proportion root caries lesions arrested as recorded by electrical caries resistance values 2. Proportion of participants with ≥one caries lesion arrested as recorded by electrical caries resistance values 3. Distance from apical border of root caries lesions to gingival margin 4. Plaque index 5. Colour of lesions	Followup: 6 months, of 186 patients (93% in control group and 102 in intervention group) Results 1. 5000 ppm F group, 52% lesions arrested vs 1100 ppm F group, 26% lesions arrested 2. Subjects per group with ≥one root caries lesions that had become hard: 5000 ppm F group, 58 (56.9%) vs 1100 ppm F group, 24 (28.6%; P 0.002) 3. Increased distance from apical border of root caries lesions to gingival margin in 5000 ppm F group vs 1100 ppm F group 4. Plaque index reduced in 5000 ppm F group vs 1100 ppm F group 5. Colour of lesions remained unchanged between groups	At 6 months, 5000 ppm F toothpaste was significantly better at remineralising root caries lesions than 1100 ppm F toothpaste.	Relatively short followup.
2) De Paolo PF (1997) ⁵ Setting: not specified	Design: controlled trial (uncertain if RCT as no information given) of 9000 ppm F gel plus 5000 ppm F gel after brushing, vs standard (1100 ppm F) toothpaste, looking at arresting root surface lesions. Both groups were shown the root surface lesions and instructed on how to brush them. Person 73 participants (mean age, 70 years) Intervention 37 participants; self-applied 5000 ppm F gel after brushing with 1100 ppm F paste but also had 9000 ppm F gel every 4 months (applied professionally) Control 36 participants; self-applied placebo gel after brushing with 1100 ppm F paste Outcome measures (no information on scoring systems or blinding): 1. Proportion lesions arrested 2. Proportion participants with arrested lesions	Followup: 1 year (no data on dropouts) Results 1. Proportion lesions arrested: intervention group, 74%; control group, 24% 2. Proportion participants with arrested lesions: intervention group, 88%; control group, 28%	Daily application of a 5000 ppm F gel, plus 4-monthly professional application of 9000 ppm F plus daily brushing with 1100 ppm F paste arrested significantly more lesions than daily brushing with 1100 ppm F paste alone.	No information on scoring system, blinding of assessors or number of dropouts. There were two interventions in the control arm and it was not possible to determine relative efficacy of daily 5000 ppm F gel vs 4-monthly 9000 ppm F gel in arresting caries.
3) Schirrmeister JF, <i>et al.</i> (2007) ⁶ Setting: dental hospital, Germany	Design: RCT comparing effectiveness of Duraphat 5000 ppm F toothpaste vs normal (1450 ppm F) toothpaste to reverse noncavitated fissure caries over a 2-week period as measured by laser fluorescence (DIAGNODent device, KaVo, Biberach, Germany). Person 30 adults (age 23–39 years; mean age, 25.5 years) Intervention Brushing with 2 cm of 5000 ppm F toothpaste 3 times per day for 3 min after meals Control Brushing with 2 cm of 1450 ppm F toothpaste 3 times per day for 3 min after meals Outcome Caries measured by DIAGNODent laser fluorescence values	Followup: all 30 participants (100%) available at 2 week followup Results 1. Laser fluorescence measurement: 5000 ppm F group, 21% decrease; 1450 ppm F group, 4% decrease (statistically significant difference P<0.01; Wilcoxon signed-rank test)	Brushing three times daily with a 5000 ppm F paste over a 2-week period significantly reduced the laser fluorescence measurement obtained from noncavitated fissure caries when compared with the same brushing regime using a 1450 ppm F paste.	Very short followup. No information given on reproducibility of values obtained.

Studies relevant to both high strength fluoride dentifrices and 22 600 ppm fluoride varnish				
4) Ekstrand K, et al. (2008) ⁷ Homes of elderly individuals, Denmark	Design: RCT comparing effectiveness of two preventive programmes in controlling root caries in older people. Person 21.5 homebound individuals aged >75 years (mean age, 81.6 years) in a suburban area of Denmark (drinking water fluoride concentration, 0.5 ppm) Intervention group 1 Once a month, a dental hygienist brushed the teeth of participants and applied Duraphat 22 600 ppm F varnish to active root caries lesions Intervention 2 Given 5000 ppm F toothpaste to use twice per day Control Given 1450 ppm F toothpaste to use twice a day Outcomes Root caries progression	Followup: 88% of participants followed up for 8 months (group 1: n=71; group 2: n=64; group 3: n=54) Results Root caries status of participants: monthly 22 000 ppm F varnish group and 5000 ppm F paste group showed significantly less progression of root caries vs the 1450 ppm F group (P<0.02). No significant difference between groups 1 and 2 (P=0.14). On average, only three out of 10 participants showed root caries progression in groups 1 and 2, vs five out of 10 in group 3.	Both the monthly varnish and high strength toothpaste intervention programmes controlled root caries development more successfully than standard toothpaste.	There was a low prevalence of root caries lesions in the study population at the start of the investigation (mean, 2.09 root caries lesions per participant). Participants in this trial were likely to be at lower risk of caries than elderly people in long-term care in the area considered because all used fluoridated toothpaste at least once per day; all lived in an area where the F concentration in the water supply was 0.5 ppm (higher than the 0.15 ppm maximum in target area); all lived in an area recognised to be just above average concerning wealth; and they regularly attended their dentists.
Studies relevant to 22 600 ppm fluoride varnish				
5) Schaecken MJM, et al. (1991) ⁸ Setting: dental hospital, The Netherlands	Design: RCT in which varnish containing 40% (w/w) chlorhexidine was applied every 3 months, immediately after professional tooth cleaning. Person 44 patients with advanced periodontal disease (2 years post- surgery) Intervention F varnish application (Duraphat 22 600 ppm F) 3-monthly, immediately after professional toothcleaning Control group Normal maintenance therapy (no specific details) Outcomes 1. DMFS for exposed roots 2. Hardening of exposed root surface lesions	Followup for 1 year Results 1. DMFS of exposed roots: Duraphat varnish group increase in DMFS, 10; normal maintenance therapy group increase in DMFS, 20 (statistically significant P<0.01) 2. Hardening of lesions: Duraphat varnish group, 11%; normal maintenance therapy group, 3% (not statistically significant)	Duraphat varnish reduced the number of DMF root surfaces compared with "normal maintenance therapy" in post-periodontal therapy patients	Participants comprised a very particular group of patients (44 individuals of mean age 44 years with advanced periodontal disease and 2 years postsurgery) with low relevance to target group. No details on what the control group had as "normal maintenance". Not possible to calculate increase in DMFS or hardened root surfaces comprehensively as no information was given on the number of surfaces within each group.
6) Ping TH (2006) ⁹ Setting: residential care homes in Hong Kong	Design: RCT forming PhD thesis successfully defended at University of Hong Kong. No published papers yet available from it, but it was considered peer reviewed. Four methods of preventing new root caries and arresting root caries were studied in institutionalised elders. Only two are relevant to this topic. Person 306 participants (60–89 years old) in care homes in Hong Kong (divided between four groups) Intervention OHI and Duraphat varnish every 3 months Control Individualised OHI only Outcome measures (assessed by a blinded examiner) Mean no. root surfaces with new caries; active root caries becoming arrested	Followup: 74% of participants followed up for 2 years Results No. root surfaces with new caries per individual: Duraphat varnish group, mean 0.89; individualised OHI only, mean 2.00 (statistically significant P<0.001). No difference found between the two groups for active root caries becoming arrested	Duraphat varnish applied 4 times per year was more effective at reducing new caries lesions on root surfaces than individualised OHI.	
RCT, Randomised control trial; DMF, decayed missing and filled, DMFS, DMF surfaces; OHI, Oral Health Instruction.				

- On completion of brushing, the mouth should not be rinsed, but as much paste as possible should be expectorated.
 - In addition, although costly, consideration could be given to applying 5% sodium fluoride varnish to the same population three to four times per year.
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