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REVIEW

The role of fluoride in the preventive management of dentin hypersensitivity and root caries

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Abstract
Objective The objectives were to bring light on fluoride to control dentin hypersensitivity (DHS) and prevent root caries.
Materials and methods Search strategy included papers mainly published in PubMed, Medline from October 2000 to October 2011.
Results Fluoride toothpaste shows a fair effect on sensitive teeth when combined with dentin fluid-obstructing agents such as different metal ions, potassium, and oxalates. Fluoride in solution, gel, and varnish give an instant and long-term relief of dentin and bleaching hypersensitivity. Combined with laser technology, a limited additional positive effect is achieved. Prevention of root caries is favored by toothpaste with 5,000 ppm F and by fluoride rinsing with 0.025–0.1 % F solutions, as the application of fluoride gel or fluoride varnish three to four times a year. Fluoride measures with tablets, chewing gum, toothpick, and flossing may be questioned because of unfavorable cost effectiveness ratio.
Conclusion Most fluoride preparations in combination with dentin fluid obstruction agents are beneficial to reduce DHS. Prevention of root caries is favorable with higher fluoride concentrations in, e.g., toothpaste.
Clinical relevance Fluoride is an effective agent to control DHS and to prevent root caries particularly when used in higher concentrations.

Keywords Fluoride · Prevention · Sensitive teeth · Hypersensitivity · Root caries

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Introduction

Tooth hypersensitivity: etiology of dentin and bleaching hypersensitivity

Tooth hypersensitivity is characterized by a rather specific sharp, intensive short duration tooth pain that is rather common among millions of people today. The most common type of hypersensitivity is caused when exposed cervical cementum/dentin surfaces through different tooth wear are exposed for different stimuli. The sensitive pain is caused by different stimuli, such as electrical (pulp testers), thermal (cold–warm), mechanical–tactile (probe-scaling), osmotic (hypertonic solutions–sugars), evaporation (air blast–air jet stimulator), or chemical stimuli (acids) cause fluid movements in the dentin tubules. A convincing theory to explain this episodic and typical pain sensation is the sc. "hydrodynamic" theory. The phenomenon was first described in the early twentieth century by Gysi [1] and was later studied and explained more in detail by Brannstrom et al. and became known as the "hydrodynamic theory" with tubule fluid provoking the pain sensation [2, 3]. Markowitz and Pashley in 2008 [4] describes a certain hypersensitivity, bleaching hypersensitivity, which may occur after tooth bleaching of sound teeth with normal enamel and dentin structure and formation. Through oxidation processes, excitability of intradental nerves increases by presence of chemosensitive ion channel TRPA1, which may be activated by a variety of oxidizer compounds including hydrogen peroxide.

Exposed cervical dentin is a result of recession of the gingival margin, commonly caused by overzealous tooth brushing procedures with abrasive toothpaste and/or frequent use of toothpicks and other tool procedures. Beyond direct wear procedures, tooth erosions may develop and create hypersensitivity. Common periodontal procedures such as gingival surgery, periodontal pocket scaling, and root planning may also cause dentin hypersensitivity (DHS). Further orthodontic, prosthetic, and restorative treatments as well as tooth whitening procedures have also been reported to increase the risk for hypersensitive teeth [5–8].

Exposure of dentin is not sufficient to cause hypersensitivity; the corresponding dentinal tubules must be open to allow for fluid diffusion. These fluid movements stimulate nerve fibers to elicit painful nerve stimuli in the pulp by activating mechanoreceptors of nerves situated at the inner ends of the tubules or in the outer layers of the pulp. It has been shown that sensitive teeth have much greater numbers of open tubules per unit area of exposed dentin as about double the average tubules' diameter compared to nonsensitive teeth. Therefore, it is postulated that the fluid diffusion in sensitive teeth is about a hundred times greater compared to nonsensitive teeth. A number of factors influence the direction of the dentinal fluid flow. Drying, cooling, and evaporation of hypertonic chemical stimuli cause the fluid to flow away from the pulp. Conversely, heating and probing cause fluid diffusion in the dentine tubules towards the pulp with interactions between the neural and hydrodynamic mechanisms in pulp and dentin [9].

A number of differential diagnoses may complicate the clinical situation, for example, pain associated with different iatrogenic dental procedures (after restorative and prosthetic treatments), dental caries, leaking dental fillings, and tooth fractures from stressful occlusion from different functional forces. The etiology of dental hypersensitivity, thus, depends on partial or total loss of enamel, e.g., from attrition, abrasion, or erosive processes and their combinations. Anthropologists, in contrast to the dental professionals, consider tooth wear as a normal physiological phenomenon with clear evidence of abrasion and attrition. Basic interactions between attrition (wear due to tooth to tooth friction), abrasion (wear between teeth and different materials), and erosion (dissolution of apatite structure by acidic) have been thoroughly described and tooth wear processes may, therefore, be implicated in the development of DHS [10–12]. DHS mostly affect subjects with permanent teeth. Although canines and premolars are the most frequented teeth with DHS, any tooth or tooth surfaces may show hypersensitivity. The prevalence of DHS presents a wide range from a few percentages to almost a 100 % due to differences in the populations studied and the methods of investigations used. Almost all patients undergoing periodontal surgery and therapy present with sensitive teeth. It must, however, be pointed out that dental hypersensitivity is a most subjective phenomena. A number of factors, efficacy in clinical studies, relationship between investigator and subject, behavior of pain history and response, placebo effect, etc. may bias such evaluations [13].

Material and methods

Literature search strategy included original scientific papers from clinical trials listed in PubMed, Medline from 2000 to October 2011 in this review. Reviews and original papers before 2000 were included covering subjects associated to the outcome of the main search. The following search terms were used: human, tooth, clinical trial, fluoride, prevention, demineralization, remineralization, exposed dentin, dentine, sensitivity, hypersensitivity, root caries, toothpaste, dentifrice, rinsing solution, fluoride gel, fluoride varnish, laser treatment, fluoride chewing gum, fluoride tablets, fluoride toothpicks, and fluoride flossing. Additional relevant information was collected from dental textbooks, scientific papers and reviews, Internet websites, and national guidelines and recommendations.

Results

Fluoride management strategies to prevent and control DHS

It is important to point out that the saliva/biofilm, the acquired pellicle on the tooth surface, confers a major protective function against tooth wear due to its lubricant function and its major role in promoting remineralization reducing the amount of mineral loss in tooth wear processes. The natural desensitization process, although slow, is nature's protection, allowing dentinal sclerosis through secondary dentin formation. Different desensitizers and fluoride measures also show various potential abilities to promote partially or total obstruction of dentin tubules and reduce DHS and tooth wear [14, 15]. The concept of tubule occlusion as a method of reducing DHS is a logical conclusion from the hydrodynamic hypothesis. This event may occur naturally through normal remineralization and sclerotic processes on the dentin surface by the normal saliva content and function. Therapeutic interventions include direct sealing of the tubules by dentin bonding agents and derivates, use of depolarizing agents or different fluoride measures ranging from toothpaste, fluoride rinsing solutions, professional application with fluoride varnish and fluoride gel application in trays, or fluoride rinsing solutions. The principal mechanism of fluoride to relieve DHS is its chemical ability to reduce and block fluid movements in the dentin tubules through formation of calcium–phosphorous precipitates as well as calcium fluoride (CaF_2) and fluorapatite (FAp) [8, 16, 17].

The Canadian Advisory Board on Dentin Hypersensitivity presented consensus-based recommendations in 2003 for the diagnosis and management of DHS [7]. The main management recommendations, among others, from the report was that following identification and removal of predisposing factors and causes of DHS, twice a day use of desensitizing fluoride toothpaste should be considered and recommended as a noninvasive first line of treatment. Orchardson and Gilliam in 2006 [18] published later an extensive review of at home-based and in-office preventive treatment alternatives to reduce DHS. In short, desensitizing treatments should be delivered systematically, beginning with prevention and at-home treatments with fluoride toothpaste and supplemented with in-office modalities as required.

Early studies with fluorides in toothpaste have shown a relative modest effect on DHS, since fluoride ions themselves do not contribute to dentine tubule occlusion. The availability and chemical access of calcium and phosphorous and proteins in saliva are more likely the source of apparent desensitizing effects. Also, some metal ions (e.g., zinc, tin, strontium, and potassium) are believed to actively affect the hydrodynamic mechanism as well as the abrasive components in toothpaste such as alumina, silica, calcium carbonate, etc. that may contribute to partial or complete obstruction of the dentine tubules. Different toothpastes with potassium salts (nitrate, chlorine, and citrate) with varying fluoride concentrations (1,100–1,500 ppm F) and different fluoride salts (NaF, MFP, AmF, and SnF_2) have been tested and found to control DHS. F-toothpaste with 0.454 % SnF_2 has been reported to be even more effective in reducing DHS after 4 weeks of daily use when compared to toothpaste with 0.76 % MFP [17, 19, 20]. He et al. [21] found significantly better immediate and ongoing sensitivity relief from a 0.45 % SnF_2 toothpaste compared to a 0.76 % sodium monofluorophosphate (MFP) toothpaste utilized as a negative control group. Other recent clinical studies have shown that a fluoride toothpaste with 1,450 ppm F as MFP combined with tubule occluding agents such as 8 % argine and calcium carbonate (Pro-Argin Technology) offers significantly increased immediate and lasting relief of dentin sensitivity in addition to being available in whitening and nonwhitening preparations [22–26]. Other attempts to reduce DHS with toothpaste containing, for example, potassium nitrate or oxalates, are given contradictionary results. In systematic reviews, Cunha-Cruz et al. [27] and Poulsen et al. [28] reported no evidence to support neither the efficacy of potassium nitrate toothpaste nor the benefit of treating DHS with oxalates with the possible exception of 3 % monohydrogen monopotassium oxalate that was demonstrated to be desensitizing beyond a placebo effect. Recently, Gendreaue et al. (2011) [29] reported, in an overview, clinical evidence for the use of NovaMin, an anhydrous toothpaste with amorphous sodium calcium phosphosilicate as providing relief from the pain of DHS. These results indicate that fluoride itself may not be necessary to control tooth hypersensitivity.

Few recent clinical studies seem to have been published with fluoride gel and mouth rinsing with regards to DHS. Aranha et al. [30] compared acidulated phosphate gel application to reduce DHS and found an efficacy similar to other potential agents (Gluma Desensitizer, Seal & Protect, Oxa Gel, and Low-level Laser). An immediate effect was observed after the use of Gluma Desensitizer and Seal & Protect, and the sensitivity level was kept the same until the end of the study. Regarding irradiation with Low-level Laser, the effectiveness was not immediate, but the sensitivity level dropped in the first week of evaluation, remaining constant until the end of the study. The desensitizer agents Oxa Gel and APF gel showed effects as of the first and third months, respectively. The use of sodium fluoride gel was found to reduce the intensity of tooth sensitivity and a 0.1 % fluoride gel combined with 5 % potassium nitrate was applied to trays associated with overnight vital bleaching and found to reduce DHS in a majority of patients, allowing most of the patients to continue bleaching to completion. Also, the use of 1.23 % sodium fluoride after bleaching regimens does not seem to affect the bleaching efficacy of carbamide peroxide [31, 32]. Further Ipci et al. (2009) [33] concluded that NaF gel in combination with laser treatment demonstrated better efficacy compared to either treatment modality alone. Presently, the effect of laser treatment is not clearly demonstrated and more basic and clinical research will be necessary.

Pereira and Chava [34] found a therapeutic effect when rinsing with a 3 % potassium nitrate/0.2 % sodium fluoride solution to alleviate DHS. However, a true control solution without fluoride was not evaluated in the study. A substantial reduction of DHS was reported by Petersson et al. [35] as a positive side effect of twice daily rinsing with an amine and potassium fluoride solution (250 ppm F) compared to a placebo solution during 12 months to control root caries progression. A fluoride-containing mouth rinse product for the treatment of DHS was found to be somewhat better compared to a placebo solution by Yates et al. [36]. However, there was no clear statistically significant difference between test and placebo solutions indicating the importance of the placebo effect in clinical trials utilizing the outcome measure of pain release [13].

Professional fluoride varnish treatment has been used rather extensively to reduce DHS with a significant and immediate pain relief effect lasting for several weeks [37–39]. The unique property of dental varnishes to remain on tooth surfaces for hours create excellent possibilities for the varnish base to penetrate deep into dentine tubules and obstruct tubule fluid movements and release high concentrations of fluoride ions forming Fap and CaF_2 for a considerable time [40, 41]. In a double-blind controlled, split mouth 8-week limited clinical study, no significant difference between different fluoride varnishes at reducing DHS was found. The hypersensitivity reduction occurred immediately after the first application and persisted during the 8-week follow-up [42]. Fluoride varnish may also reduce and prevent dentin dehydration prior to bleaching treatment, since it has been shown that glycerine-based bleaching products may dehydrate fluid in dentin tubules causing dentin hypersensitivity. Clinical evaluation has also been performed with laser therapy and fluoride varnish to treat cervical DHS, which demonstrated an improved response on teeth with higher degrees of sensitivity. Studies involving Nd:YAG laser, ER:Yag laser, and CO_2 laser present a slight clinical advantage over topical medicaments such as fluoride varnish and bonding agents in the treatment of DHS, but more controlled clinical studies are needed to confirm this statement. It is interesting to observe that dentin adhesive systems and desensitizers may prevent root demineralization although hitherto under in situ experimental conditions [43–46].

The oral health in elderly and the risk for root caries development

Most elderly Europeans will have more natural teeth with a possible increase in oral problems due to dental caries on exposed cervical dentine surfaces. In several industrialized countries, there have been positive trends in the reduction of dental caries in children and reduction of tooth loss among adults, but still dental caries has not been eradicated in children although it has been brought under control in some countries. The burden of oral disease among older people is high and this has a negative effect on their quality of life [47–49]. Recent data by Johansson et al. [50] conclude that oral health, even among the elderly, have benefited from regular utilization of dental care and preventive measures, thus stressing the future responsibilities for the community, professionals, researchers, and the drug companies to improve conditions for the caries preventive measures for this population.

Exposed cervical dentin increases the risk for development of root caries, since the dentin is less resistant to acid attacks compared to enamel. Dentin and cementum contain comparatively lower volume percentage of apatite mineral and smaller hydroxyapatite (HAp) crystallites. Demineralization of exposed dentin occurs already at pH 6.2–6.4 compared to pH 5.5–5.7 for enamel and acid attacks in the plaque/biofilms cause destructive hard tooth changes being approximately twice as rapid compared to similar processes in enamel [51–53].

Oral infections and systemic diseases are an emerging problem in elderly people being described by Rautemaa et al. [54]. There are a number of potential medical and oral risk factors and determinants for dental caries in elderly. Fure and Zickert [55] have concluded that significant risk factors for root surfaces are the same as for enamel surfaces, e.g., reduced salivary secretion and buffer capacity, high frequency of carbohydrate intake, high levels of plaque, and cariogenic microorganisms in plaque biofilm and saliva. Both salivary components and flow rate have an important protective role against dental caries through cleaning of the oral soft and hard tissues in the mouth, diluting the acids in the mouth, and being a reservoir of repairing minerals and contributing to an antimicrobial resistance in the biofilm on the tooth surfaces [56, 57]. Thus, it seems obvious that older individuals are at risk for root caries due to partial dentures, caries frequency in combination to lack of dexterity, insufficient saliva properties, cariogenic food and drink intake, shift to cariogenic bacteria in the tooth biofilm, poor oral hygiene, and, not at least, insufficient and ineffective fluoride treatment as pointed out by Gati and Vieira (2008) [58].

The use of fluoride has been considered for decades as being the main cornerstone of caries prevention and control by reducing the rate of demineralization, stopping caries progression, and promoting remineralization and, under certain circumstances, even carious lesion arrest. Additionally, fluoride can interfere with the physiology of oral bacteria in the tooth biofilm, decreasing the acid production and inducing cariogenic bacteria acid intolerance [59, 60].

The efficacy and efficiency of fluoride prevention of caries

Systematic reviews of caries prevention have been extensively been presented by the Swedish Council on Technology Assessment in Health Care (www.sbu.se) and the Cochrane Database Syst Rev [61–67]. The main conclusions from these reviews are that the relative caries preventive effects of common fluoride preventive measures are acceptable but that the scientific evidences for many methods are weak and insufficient for children and young adolescents. Of note, the relevant scientific information on the effectiveness of fluoride in adults and elderly is comparatively low or even nonexistent compared to those of children and adolescents.

One systematic review found fluoride to be effective in preventing dental caries among adults while examining the effectiveness of self- and professionally applied fluoride and water fluoridation. Griffin et al. [68] were using a random effects model to estimate the effect size of fluoride for all adults aged 20+ years and for adults aged 40+ years. Among studies publishing any fluoride, self- and professionally applied or water fluoridation showed 29 % reduction for coronal caries and 22 % for carious root surfaces. The prevented fraction for water fluoridation was 27 %. These findings suggest that fluoride prevents caries among adults of all ages. A review of preventive interventions for root caries showed that additional fluoride appears to be a preventive and therapeutic choice for treatment of root caries and that more fluoride seems to be needed for remineralization of root dentin lesions as well as for advanced enamel lesions [69, 70]. Rodrigues et al. [49] recently described the preventive effect on crown and root caries, respectively, and concluded that higher fluoride concentration may be necessary to prevent and control root caries compared to crown caries. However, the overall scientific evidence of fluoride treatment in adults is limited. Mukai et al. [71] found in an experimental in vitro study that a 0.4 %F solution remineralized shallow and deep root surface caries in vitro and Baysan et al. [72] found and demonstrated in a clinical study with 5,000 ppm F toothpaste that it is significantly better at remineralizing primary root caries lesions (PRCLs) than one containing 1,100 ppm F. Ekstrand et al. [73] compared the efficacy between daily use of two toothpastes, one with 5,000 ppm F and the other containing 1,450 ppm F on patients older than 75 years during 8 months. The 5,000 ppm F toothpaste showed significantly better effect in controlling root caries development supporting the hypothesis that higher fluoride concentrations in toothpaste may be beneficial for the control of root caries.

There have been scientific discussions if different fluoride salts or fluoride measures would vary concerning their clinical efficacy to control root caries. Parakevas et al. [74] studied root caries development in patients receiving periodontal therapy and compared solutions containing amine fluoride/stannous fluoride versus sodium fluoride on remineralization of early root caries lesions. They found no significant difference between the two fluoride salts used. Fure and Lingstrom [75] evaluated two different fluoride treatments (Duraphat varnish with 2.23 %F and an 8 % stannous fluoride solution in randomly selected groups with 60 root lesions). Interestingly, no obvious differences were found after 1 year and concluded that frequent topical application with high fluoride concentrations could be a successful treatment for incipient root carious lesions. Further, Petersson et al. (2007) [35] have tested an amine F solution (0.025 % F) twice a day during 1 year against a placebo solution and found significant remineralization of active root caries lesions from the active fluoride solution and additionally, a potential reduction of DHS.

Caries prevention with fluoride and health care economics

A number of different economic assessments (e.g., cost–benefit, cost effectiveness analyses, etc.) have been applied in the dental health care sector in order to meet an increased demand for efficient and alternative preventive treatments [76, 77]. A systematic review by Källestål et al. [78] of economic evaluations of caries prevention showed that studies do not provide support for any significant economic value of many caries preventive measures. The reviewed fluoride studies show that results for fluoride varnish treatment and fluoride rinsing are low to moderate in effectiveness and for other fluoride measures, there are not enough scientific evidence data available. The effectiveness of fluoride toothpaste shows, as expected, results with high evidence values. Splieth and Flessa [79], in a lifelong cost model of caries, have demonstrated that the use of fluorides in caries prevention is highly cost effective. Their conclusions were that a number of dental health parameters represent measures of quantifiable values that include improved quality of life, less time spent for dental treatment, and additionally, reduced chances of clinical complications.

A recent National Guideline report to further analyze and judge the different caries preventive methods for adults from a health economic point of view has been presented by the National Board of Health and Welfare (Sweden). These guidelines serve as a support for those who make decisions concerning the allocation of resources within health and medical care and social services. The goal of these guidelines is to contribute towards patients and clients receiving a high standard of medical care and social services in a transparent process of independent experts (National Guidelines 2011) [80]. The outcome suggests a ranking system alternative from one to ten about dental status and treatment alternatives based on the severity of dental status, effect of the treatment, cost effectiveness ratio, and evidence of the conclusion from the scientific background analyzed in expert groups. Ranking order one to three was suggested to give the highest priority and ranking seven to ten, the lowest. Besides the ranking procedure, treatment alternatives were classified as “not-do” recommendations or recommendation to be used only within research programs.

The clinical recommendations with NaF/MFP or amine fluoride toothpaste containing 1,000–1,500 ppm F has a high priority for subjects having risk for root caries, meaning that subjects have a need for intervention to preserve his/her oral health and or prevent further root caries development. In comparison, stannous fluoride toothpaste (1,000–1,500 ppm F) has received a

Table 1 Priority ranking (1–10) of preventive measures and health economic assessment (±HEA). Diagnose: "Risk for root caries". Ranking 1–3=high priority/ranking 4–6=moderate priority/ranking 7–10=low priority

Preventive measure	Risk for root caries	
	Ranking	HEA
F-toothpaste/NaF/MFP/AmF		
1,000–1,500 ppm F/twice a day	3	+
SnF_2-toothpaste		
1,000–1,500 ppm F/twice a day	10	–
F-toothpicks/daily[a]	10	–
F-dental floss/daily[a]	10	–

F fluoride, *SnF_2* stannous fluorde

[a] Several times a day

low ranking; therefore, it is suggested not to be used. The main reason for this is higher cost and also the problem that it causes discolorations on teeth. The clinical use of F-toothpicks and F-dental floss is further not recommended, since their additional preventive effect to regular use of F-toothpaste are insufficiently documented (Table 1).

The general recommendation to use fluoride tablets, F-chewing gum, or professional tooth cleaning with F-containing polishing pastes is low in subjects with increased risk for "root caries" (active lesions) (Table 2). Daily fluoride rinsing with 0.025–0.1 % fluoride solution is recommended as for fluoride gel treatment in tray or fluoride varnish two to four times a year to subjects with "increased" risk or those subjects with "initial root caries lesions" with a risk for progression. Fluoride toothpaste with 5,000 ppm F can also be recommended to use for these groups of subjects.

Conclusion

Fluoride prevention and control of tooth hypersensitivity and dentin as well as bleaching hypersensitivity can modestly be realized by using toothpaste with concentration between 1,000 and 1,500 ppm F as NaF, MFP, or AmF. Fluoride and different combinations of agents with occluding properties of the dentin tubules such as metal ions, silica and nitrate, and oxalates may improve this effect. Toothpaste with stannous fluoride show somewhat better effect but show disadvantages with discolorations of teeth. The recent data with fluoride toothpaste plus argine (Pro-Arg Technique) are promising without obvious clinical disadvantages. However, more controlled studies are required to make fair comparison with so-called normal fluoridated toothpaste. The clinical use of fluoride as mouth rinsing, fluoride in gels and, not at least, fluoride varnishes show comparatively acceptable efficacy to control DHS compared to other measures. The combination of fluoride with laser technology is promising to control tooth hypersensitivity. Laser research must be intensified and show promising results in order to become accepted as a method to control tooth hypersensitivity.

The development of root caries is increasing in the elderly. The regular use of fluoride is of great importance to prevent and to control root caries but there seems to be a need to use higher fluoride concentration at higher risk. Thus, subjects with "risk" for root caries should be recommended to use fluoride toothpaste with concentrations between 1,000 and 1,500 ppm F as NaF, MFP, or AmF. For subjects at "high risk" with active root caries lesions and with risk for lesion progression, fluoride toothpaste containing 5,000 ppm F, frequent fluoride mouth rinsing with 0.025–0.1 % fluoride solution, and topical application of fluoride varnish two to four times a year or the use of

Table 2 Priority ranking (1–10) of different preventive measures and health economic assessment (±HEA). Diagnose: increased risk for root caries (active lesion). Ranking 1–3=high priority/ranking 4–6=moderate priority/ranking 7–10=low priority

Preventive measure	Increased risk-root caries	
	Ranking	HEA
F-toothpaste (5,000 ppm F)		
twice a day	3	+
F-rinsing/daily		
(0.2 %-NaF)	3	+
F-rinsing/daily (0.05 % NaF)	4	+
F-gel (in tray)/daily	3	+
F-varnish/2–4 times a year	3	+
Fluoride tablets/daily[a]	7	–
F-chewing gum/daily[a]	7	–
Professional tooth-cleaning with F-paste/every 2nd month	6	(+)
SnF_2 gel/4× year	6	(+)

F fluoride, *SnF_2* stannousfluoride

[a]Several times

fluoride gel in trays can be recommended from a health care economic judgment. Other common fluoride regimens may be questioned because of their low efficacy and clinical disadvantages based on health economic evaluations. Continuous follow-up of clinical recommendations of different preventive fluoride measurement strategies are necessary and should be evidence based.

Conflict of interest None.

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