The Role of Dietary Fluoride Supplements in Caries Prevention

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Abstract

Nearly all dental researchers and public health authorities agree that fluoride supplements are highly effective in reducing dental caries in primary and permanent teeth, that benefits to all teeth are greater when administration begins at 2 years of age or younger, that both preeruptive and posteruptive exposure is important in imparting cariostatic benefits, that effectiveness is neither enhanced nor reduced by their being combined with vitamins, and that benefits to the offspring of pregnant women who take supplements are uncertain. Several studies show that fluoride supplements delivered in school-based programs effectively reduce dental caries, and benefits are greater to teeth that receive preeruptive exposure in addition to posteruptive exposure. Many parents who, for a variety of reasons, did not administer fluoride supplements at home will enroll their children in school-based fluoride tablet programs. Effectiveness of fluoride supplements today is undoubtedly smaller than observed previously because of dilution and diffusion effects from other fluoride sources; nevertheless, they still have the same potential efficacy. It is apparent that the current ADA dosage schedule is too high and requires modification; however, the availability of this known-to-be-effective regimen should not be eliminated or restricted. [J Public Health Dent 1999;59(4):205-10]

Key Words: fluoride supplements, school-based preventive programs, caries-preventive programs, preeruptive fluoride, fluoride dosage schedule.

Dietary fluoride supplementation has been considered for many years as an effective alternative to community water fluoridation for providing systemic and topical fluorides to infants, children, and adolescents. Dozens of studies have shown that the use of dietary fluoride supplements is effective in reducing the incidence of dental caries in the primary teeth and permanent teeth of children. The format of this paper does not permit a summary and critique of individual studies that support this conclusion. Fortunately, several excellent reviews of dietary fluoride supplements have been published (1-5), and I shall rely mostly on the observations of these reviewers in my assessment of the historical perception of dental researchers on the value of dietary fluoride supplements in caries prevention.

Dietary fluoride supplements have been available commercially since the

1940s and currently are marketed in the form of vitamin fluoride combination products, as well as fluoride drops, tablets, lozenges, and oral rinses. They are available in the United States only by prescriptions written by physicians or dentists (and, in some states, by other authorized health care personnel). Generally, fluoride drops are given to infants and toddlers until sometime after the complete primary dentition has erupted (about age 2), and children can control the proper use of fluoride tablets.

Conscientious adherence to the recommended dosage schedule for fluoride supplements can produce protection from dental caries similar to or even exceeding that produced by consuming optimally fluoridated drinking water. Systemic benefits from consuming fluoride supplements may exceed those from drinking fluoridated water because the former deliver a precise amount of fluoride daily, whereas water consumption varies greatly among children in a fluoridated community. Unlike supplements, fluoridated water is consumed alone, in beverages and in foods throughout the day and, thus, provides repeated topical exposure of erupted teeth to fluoride each time the fluoride-containing beverage or food is placed in the mouth. Systemic fluoride is secreted via the salivary glands and gingival exudate in low, but clinically important, concentrations. Moreover, fluoride is stored and concentrated in dental plaque from which it is mobilized to enhance the enamel remineralization process during periods of cariogenic challenge. The precise effectiveness of each of these mechanisms of fluoride action is not known because they work in concert and separating the effects of any one from the others cannot be done.

The current dosage schedule for dietary fluoride supplements recommended by the American Dental Association (ADA) is shown in Table 1 (6). The dosage schedule of the American Academy of Pediatrics (AAP), since 1979, has been the same as that recommended by the ADA, except that the AAP recommends that supplementation begin at 2 weeks of age rather than at birth, and that it be continued through age 16 rather than through age 13 (7).

The regimen requires that a supplement be given or taken daily for a prolonged period (13 or 16 years). Compliance with the schedule by practitioners, parents, and children has been considered poor. Practitioners must continue to prescribe fluoride supplements, parents must give them to their young children, and as they get older, children themselves must remember to take them and not rebel against their parents' reminders and urgings to follow the regimen.

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 TABLE 1

 ADA Recommended Dosage Schedule for Dietary Fluoride Supplements (in mg F/Day) According to Fluoride Concentration of Drinking Water and Age

Age (Years)	F Concentration of Drinking Water (ppm)		
	<0.3	0.3-0.7	>0.7
Birth to 2	0.25	0	0
2 to 3	0.50	0.25	0
3 to 13	1.00	0.50	0
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Effects in Primary Teeth

In 1974 Driscoll (1) published an exhaustive review of dietary fluoride supplements. At that time, he identified 18 studies that had measured the cariostatic effects of fluoride supplements in primary teeth. Driscoll stated that " ... positive findings were reported in all but three of the 18 studies" (1). He also pointed out that "It was evident that the benefits were generally greater in those studies in which the initial ages of the children averaged near 2 years or younger ..." (1). He summarized overall findings in primary teeth as follows: " ... the majority of studies have reported caries reductions in deciduous teeth of approximately 50 to 80 percent when fluoride administration was begun before about 2 years of age and was continued for a minimum of three to four years" (1).

In 1986 Murray (4) reported that his review showed that 55 studies of the effectiveness of fluoride tablets or drops had been published. Twenty of these trials measured the effects of fluoride supplements in the primary dentition. Duration of supplement use in these studies ranged from one to 12 years. Murray (4) stated that the studies showed that if administration of the dietary fluoride supplements was initiated at age 2 or younger, a consistent caries-preventive effect in primary teeth was observed consistently in the range of 50 to 80 percent.

Mellberg and Ripa (2), in their review of essentially the same studies, noted that the majority " ... are positive, with reductions of 30% or more reported ..." and that reductions " ... as high as 70% to 80% ... " were observed (2). They concluded from their review that "Greater effects to the primary dentition were found to accrue when fluoride supplements are started at birth. Conversely, supplementation beginning at age 3 or 4 is generally less effective or ineffective [in the primary dentition]" (2).

Wei (5), in a 1986 review, stated that studies in primary teeth show " ... a significant [cariostatic] effect, whether or not the supplementation began from birth." He continued, however, by saying, "There appears to be slightly more benefit if the supplementation began at birth compared to its initiation of usage at later years" (5). Wei also noted that studies conducted for less than three years " ... showed less cariostatic benefits than those that commenced at or near birth and continued for five or more years" (5). In his 1985 textbook, Nikiforuk (3) specifically pointed out that caries-preventive effects were not detected in primary teeth in three studies in which ... fluoride supplements were first administered when the children were 3 years or older." He continued, "Such studies do not measure optimal effects, since many teeth have formed and erupted prior to fluoride ingestion and hence only topical benefits are detected" (3).

Effects in Permanent Teeth

In his review, Driscoll (1) pointed out that benefits in 28 studies of effects of dietary fluoride supplements in permanent teeth appeared to be somewhat lower than those reported for primary teeth, although he could not offer an explanation for these discrepant relative findings. He noted that "... children who began fluoride ingestion at younger ages derived greater benefits than children who were older at the start of the study" (1). Driscoll stated that the collective data from clinical studies of fluoride supplementation suggest that both preeruptive and posteruptive exposure are important in imparting cariostatic benefits to the teeth, and that exposures should

begin shortly after birth to provide maximal benefits to primary and permanent teeth (1).

Murray (4), in 1986, summarized the findings of 32 trials of the cariostatic effects of dietary fluoride supplements in the permanent dentition. He noted that in four of the trials fluoride supplements were taken from birth for at least seven years and these studies showed reductions in caries ranging from 39 percent to 80 percent (4). Findings of studies in which the subjects were older at initiation of the regimen and in which the duration of usage was shorter produced lesser relative benefits. A few of the studies in which the regimen lasted for only a year or two and/or in which the subjects were 5 years of age or older at initiation demonstrated negligible or an absence of benefits. Murray (4) observed, as have several other reviewers, that the effectiveness of dietary fluoride supplements is neither enhanced nor reduced by their being combined with vitamins.

Mellberg and Ripa (2), in their review of essentially the same studies, concluded that dietary fluoride supplements containing either neutral or acidulated sodium fluoride were both effective in caries prevention in permanent teeth. They noted particularly that two studies in which supplementation was started at birth demonstrated reductions in caries increments of 70 percent and 80 percent, and stressed that systemic exposure of developing teeth to fluoride is important for maximal protection against caries.

In his review of dietary fluoride supplements, Wei (5) stated that reductions in caries in permanent teeth have been " ... generally directly proportional to the number of years of continuous usage." He further asserted that "While most of the clinical trials discontinue fluoride supplementation at age 13, the longer the use is continued beyond this age the greater should be the total benefits" (5). This opinion is in accordance with current scientific knowledge of the importance of frequent exposure to low concentrations of fluoride as a facilitator of remineralization during periods of cariogenic challenge.

Nikiforuk (3) summarized the overall effects of dietary fluoride supplements as follows: "The collective data strongly support the conclusion that the use of fluoride supplements prior to and during the development of dentitions results in a caries reduction that apparently duplicates the benefits of water fluoridation."

In essence, the authors of five reviews (1-5) concurred that (1) dietary fluoride supplements are highly effective in reducing dental caries in primary and permanent teeth, (2) benefits are greater in both primary and permanent teeth when administration begins at 2 years of age or younger, (3) both preeruptive and posteruptive exposure is important in imparting cariostatic benefits to the teeth, and (4) effectiveness is neither enhanced nor reduced by their being combined with vitamins. It is only fair to mention that this unanimity of opinion is not surprising, inasmuch as all the reviewers had essentially the same body of reported clinical studies at their disposal.

Burt and Eklund (8), however, in their 1992 textbook, are not enthusiastic about the need for dietary fluoride supplements. They state that "There is sufficient evidence from well-conducted studies ... to show that fluoride supplements exert some caries-preventive effect," but they also say that "... their continued prescription under the current [dosage] schedule needs to be thoughtfully reviewed" (8). They cite the following reasons for their coolness toward fluoride supplements: current evidence that the systemic action of fluoride is relatively minor, problems with compliance, and their identification as a risk factor for dental fluorosis. Burt and Eklund's (8) depiction of fluoride supplements as " ... clearly not an unmixed blessing" seems rather harsh to me.

Effects of Prenatal Exposure to Fluoride

The data on benefits to the offspring of pregnant women who take dietary fluoride supplements remain equivocal. Theoretically, primary teeth, which begin to develop prenatally, might benefit from exposure to fluoride in utero. Permanent teeth are unlikely to benefit because little, if any, development of these teeth occurs before birth. The Food and Drug Administration (FDA) considers any fluoride preparation labeled, represented, or advertised for prenatal use as being misbranded and subject to regulatory proceedings (9).

Effects of School-based Programs

Several studies have been done in which fluoride tablets have been administered in schools, usually supervised by teachers. In these studies children did not begin to use fluoride supplements until at least aged 5 or 6 years. Supplementation begun at school age provides minimal preeruptive exposure of first permanent molars and incisors to fluoride, but lengthy preeruptive exposure to cuspids, premolars, and second molars. All erupted permanent teeth will receive topical fluoride exposure on school days, as fluoride tablets are chewed and the resultant salivary solution is swished between the teeth before swallowing.

At least two school-based studies of fluoride supplement use have shown that teeth that erupted during the course of the study received greater relative decay-preventive benefits than teeth already erupted when the study was initiated. DePaola and Lax (10) reported an overall 23 percent reduction in DMFS among children initially aged 6 to 8 years after two years of a daily fluoride tablet program. However, the reduction in DMFS among teeth that erupted during the trial was 53 percent. Driscoll and his co-workers (11) found a 28 percent reduction in DMFS among children 6 or 7 years old who used a fluoride tablet on school days for six years; however, the relative protection to late-erupting teeth receiving both preeruptive and posteruptive exposure to fluoride was twice as great as the early erupting teeth essentially receiving only posteruptive exposure to the fluoride.

It is impossible to ascertain whether the greater relative benefits to newly erupted teeth result from a preeruptive fluoride effect or from the fact that newly erupted teeth are relatively immature and incorporate fluoride readily. Nevertheless, these findings underline the importance of early exposure of teeth to fluoride. The study by Driscoll et al. (11) is unique because one group of children ingested two fluoride tablets each day with as lengthy an interval between tablet administration as practicable in a school setting. No advantage was observed among the children who used two tablets (2 mg F) per day compared with those who used one (1 mg F). Another singular facet of the study was that the investigators ascertained post-treatment effects four years after tablet usage was discontinued (12). They found that the benefits in both tablet groups persisted at nearly the same level of caries protection during the lengthy nontreatment interval as had been observed following six years of usage (12).

Fluoride tablets also have been part of comprehensive school-based cariespreventive regimens. One 11-year evaluation was done in Nelson County, Virginia, in which schoolchildren in all grades were provided with a fluoride dentifrice for use at home as well as a fluoride tablet in school on school days. In addition, children in elementary and junior high school rinsed weekly with a 0.2 percent sodium fluoride solution (13). A reduction in caries prevalence among students in Nelson County schools of 65 percent was observed after 11 years. DMFS in approximal tooth surfaces declined by 90 percent from 1972 to 1983 (13). Because the three-component program was provided to all children, the effect of the dietary fluoride supplement itself could not be determined. The timing of the study coincided with the secular decline in caries that was occurring in the United States during the same interval. However, as the authors pointed out (13), the national decline occurred primarily for the same reasons as those responsible for the decline in Nelson County-the widespread use of fluorides-except the use was formalized in Nelson County.

In a prospective study, kindergarten and first grade students in a nonfluoridated community used a fluoride mouthrinse weekly, a fluoride tablet daily, or a combination of both procedures for eight school years (14). DMFS increments were 3.57, 2.83, and 2.40 in the three groups, respectively. Only the difference between the fluoride mouthrinse group and the combination tablet/mouthrinse group was statistically significant. For ethical reasons, an untreated or placebo-treated control group was not included in the design of the study. Therefore, the absolute benefits of any of the preventive regimens could not be ascertained. Despite the low increments of dental caries during the study, the authors concluded that "eight-year findings ... demonstrate that a combined procedure of weekly fluoride mouthrinsing and daily fluoride tablet administration provides an additional caries-preventive benefit compared with the presumed benefit afforded by use of the fluoride mouthrinse alone" (14).

Many parents who, for a variety of reasons, did not administer dietary fluoride supplements at home will enroll their children in school-based programs in which dietary fluoride supplements are offered. Many of these children are likely to benefit greatly from the school program in areas with high levels of dental caries. If it were recommended that dietary fluoride supplements be eliminated from the caries-preventive armamentarium—a position that will be advanced in this workshop—manufacturers likely would not continue to produce them solely for possible school-based programming; the potential market for fluoride supplements sold only for school programs probably would not justify manufacturing and promotional costs. Another, probably more critical, consideration in connection with eliminating the perceived need for dietary fluoride supplements is that such a recommendation would undermine the justification and scientific rationale for continuing efforts to implement and even retain community water fluoridation.

Current Effectiveness

Nearly all studies of the caries-preventive effects of dietary fluoride supplements were done before there was general recognition that the prevalence of dental caries had declined appreciably among children in the United States and many other Western countries. Findings of 70 percent and 80 percent reductions in the incidence of dental caries from the long-term use of fluoride supplements were observed when dental decay in children was much greater than it is today. As Ripa (15) has pointed out, " ... trials of fluoride tablets in the US that used concurrent placebo controls were all conducted more than a decade ago, before the major decline in caries prevalence had been documented." More recent studies of supplements have involved their use in schoolbased programs or to answer specific questions, such as those concerning effects of prenatal administration. It must be presumed that if studies of dietary fluoride supplements were conducted today, absolute benefits and probably percentage reduction effects would be smaller than those observed previously.

The most recent national survey of US schoolchildren conducted by the National Institute of Dental Research (NIDR), completed in 1987, showed that children who were life-long residents of communities with drinking water at optimal or greater concentrations of fluoride had only 18 percent fewer DMFS than did children who had always lived in communities with fluoride-deficient water (16). Even when children with histories of fluoride supplement use, professional applications of fluoride, or participation in school-based fluoride programs were eliminated from the comparison, the difference in DMFS prevalence increased only to 25 percent (16). Ripa (15) refers to this apparent diminution of measurable benefits of community water fluoridation as a "dilution" effect, resulting from today's widespread use of other fluoride-containing products, which has tended to lower levels of dental caries in both fluoridated and nonfluoridated areas.

Newbrun (17) and Ripa (15) have pointed out that differences between caries scores of children with life-long exposure and without exposure to fluoridated drinking water tend to be greater in regions of the country with relatively low percentages of the population who live in communities with fluoridated drinking water. A hypothesis for this observation is that persons in nonfluoridated communities in regions with relatively little water fluoridation have fewer opportunities to benefit from consuming foods and beverages processed in nearby fluoridated communities or to visit (and consume drinking water in) such communities compared with persons in nonfluoridated areas in regions with many fluoridated communities. Ripa (15) has defined this extension of benefits of community water fluoridation to residents of fluoride deficient communities as a "diffusion" effect, a term that I believe is an improvement over the vague, imprecise "halo effect" of community water fluoridation, which has been used widely in recent years for the same phenomenon.

The point of this discussion is that the effectiveness of dietary fluoride supplements today, if they were to be evaluated in controlled clinical trials, undoubtedly would be smaller than was observed previously because of the dilution and diffusion effects I have described. It is not possible to state a precise range of effectiveness under prevailing conditions. Certainly, claims are no longer justified that regular use of dietary fluoride supplements from birth will reduce dental caries by 50 to 80 percent in the United States. Such claims, which could be documented by study results, were made frequently in reviews until fairly recently.

Dietary fluoride supplements, when used as directed, have the same efficacy as they always had. In other words, if the diffusion effects of community water fluoridation and the dilution effects of other fluoride containing products and procedures did not exist in the United States, use of the currently recommended dosage schedule for fluoride supplements would be capable of reducing dental caries prevalence profoundly in children and adolescents, with minimal attendant risks of dental fluorosis. But, reality must be faced: supplements no longer exist alone as an exclusive systemic and topical source of fluoride.

Concluding Comments

In a 1992 commentary on dietary fluoride supplements, Szpuner and Burt (18) took a strong stand against the need for dietary fluoride supplements in the United States. They concluded by stating " ... the evidence shows that continued use of dietary fluoride supplements is not warranted as a routine public health measure" (18). They cited weak evidence of a preeruptive systemic effect of fluoride, a high risk of fluorosis, and the ready availability of other forms of fluoride as a basis for their position. They continued by conceding that fluoride supplements " ... for high-risk individuals may be beneficial, though even this practice deserves careful study" (18).

I am surprised by their position, especially with respect to the lack of a preeruptive cariostatic effect of fluoride. Their commentary largely ignores the evidence for such an effect that I have referred to in this paper, plus other research findings demonstrating a preeruptive effect. For example, one reported study by Burt et al. (19) showed that 6- or 7-year-old children who lived in a community with only 0.2 ppm fluoride in the water but who had exposure previously to fluoridated water-mostly before eruption of their permanent teeth-not only had fewer DMFS initially, but also developed 27 percent fewer DMFS during the next three years than did children of the same ages who had lived in the low-fluoride community all their lives. The differences were statistically significant. In my opinion, these findings are among the strongest to document preeruptive benefits of fluoride (20). Yet, Szpuner and Burt (18) essentially ignore their own work in formulating their opinion on the value of preeruptive fluorides.

It would be wrong, in my opinion, to eliminate or curtail the availability of dietary fluoride supplements as a caries-preventive regimen because many children are still at high risk to dental caries and, for a variety of reasons, may not have access to fluoridated drinking water or professionally administered fluoride regimens, or may not use other fluoride-containing products to any meaningful extent. Fluoride supplements used at home for such children are a way to improve their oral health greatly. To state that home-based programs of dietary fluoride supplement use are unfeasible because compliance is poor constitutes a self-fulfilling prophecy of failure (20,21). Rather, ways must be developed to improve awareness and appreciation of good oral health, which will lead to greater compliance.

Existing data clearly show that postponing use of dietary fluoride supplements until age 2 or 3 years will reduce their potential effectiveness in caries prevention, particularly for primary teeth. In my opinion, it is wrong to postpone initiating dietary fluoride supplementation, as has been suggested in some recent policy recommendations or dosage schedules, because doing so will permit the development of a dental disease (caries) in some children, which could have been prevented.

It is apparent that the current dosage schedules of the American Dental Association and the American Academy of Pediatrics are too high today for children of certain ages if one considers the ubiquity of fluoride-containing products on the market and the diffusion effects of community water fluoridation. Certainly, enough circumstantial evidence exists to recommend an empirical, downward revision of the current dosage schedule for children younger than school age to reduce the risk of dental fluorosis. The assembly at this workshop will hear suggestions for such a revision and we should be able to make a specific recommendation based on the evidence. A downward revision in dosage is very different than a recommendation for elimination of dietary fluoride supplements.

It is well documented that many young children may ingest sizeable, biologically important quantities of fluoride when they brush their teeth with fluoride toothpastes. Some efforts have been made to educate dentists, hygienists, and the public about appropriate toothpaste quantities and toothbrushing techniques for preschool-aged children. Nevertheless, children susceptible to developing dental fluorosis continue to swallow excessive quantities of fluoride from toothpastes daily. Yet, I have not seen or heard recommendations that fluoride toothpastes should be removed from the market. There has not even been serious interest on the part of regulatory agencies, professional organizations, or manufacturers in this country to foster the marketing of dentifrices with lower fluoride concentrations for younger children to reduce the risk of their developing dental fluorosis. Although more surveys to date have shown an association of dental fluorosis with the use of dietary fluoride supplements than with the early use of fluoride toothpastes, the fact that nearly all children use fluoride toothpaste and relatively few take dietary fluoride supplements means that fluoride toothpaste undoubtedly has had a greater overall impact on observations of increased fluorosis in our country than have fluoride supplements.

With respect to dietary fluoride supplements, I believe that we must revise the current dosage schedule based on use of the best scientific information we have available today. Let's not, however, irretrievably eliminate these known-to-be-effective products for preventing dental caries. In medicine, disease preventives are rare that work as well as fluoride supplements do in preventing dental decay. We must ask ourselves whether we, because of our own concerns, would be doing a disservice to subgroups of the US population by taking action that would eliminate or curtail the availability of dietary fluoride supplements.

References

- 1. Driscoll WS. The use of fluoride tablets for the prevention of dental caries. In: Forrester DJ, Schulz Jr EM, eds. International workshop on fluorides and dental caries reductions. Baltimore, MD: University of Maryland, 1974:25-96.
- Mellberg JR, Ripa LW. Dietary fluoride supplementation. In: Fluoride in preventive dentistry—theory and clinical applications. Chicago: Quintessence, 1983: 123-49.
- Nikiforuk G. Alternatives to water fluoridation. In: Understanding dental caries. Vol 2. Prevention, basic and clinical aspects. Basel, Switzerland: Karger, 1985: 29-41.
- 4. World Health Organization. Dietary fluoride supplements—school water and milk fluoridation. In: Murray JJ, ed. Appropriate use of fluorides for human health. Geneva, Switzerland: World Health Organization, 1986:84-99.
- 5. Wei SHY. Fluoride supplements. In: Newbrun E, ed. Fluorides and dental caries—contemporary concepts for practitioners and students. 3rd ed. Springfield, IL: Charles C. Thomas, 1986:33-49.
- American Dental Association. Accepted dental therapeutics. 40th ed. Chicago: American Dental Association, 1984:401.
- Committee on Nutrition, American Academy of Pediatrics. Fluoride supplementation: revised dosage schedule. Pediatrics 1979;63:150-2.
- Burt BA, Eklund SA. Dentistry, dental practice and the community. 4th ed. Philadelphia: WB Saunders, 1992:176-8.
- Food and Drug Administration. Statements of general policy or interpretation, oral prenatal drugs containing fluorides for human use. Federal Register 1966; Oct 20.
- DcPaola PF, Lax M. The caries-inhibiting effect of acidulated phosphate-fluoride chewable tablets. A two-year doubleblind study. J Am Dent Assoc 1968;76: 554-7.
- Driscoll WS, Heifetz SB, Korts DC. Effect of chewable fluoride tablets on dental caries in schoolchildren: results after six years of use. J Am Dent Assoc 1978;97: 820-4.
- Driscoll WS, Heifetz SB, Brunelle JA. Caries preventive effects of fluoride tablets in schoolchildren four years after discontinuation of treatments. J Am Dent Assoc 1981;103:878-81.
- Horowitz HS, Myers RJ, Heifetz SB, Driscoll WS, Li S-H. Combined fluoride, school-based program in a fluoride deficient area: results of an 11-year study. J Am Dent Assoc 1986;112:621-5.
- 14. Driscoll WS, Nowjack-Raymer R, Selwitz RH, Li S-H, Heifetz SB. A comparison of the caries-preventive effects of fluoride mouthrinsing, fluoride tablets, and both procedures combined: final results after eight years. J Public Health Dent 1992; 52:370-4.
- 15. Ripa LW. A half-century of community water fluoridation in the United States:

review and commentary. J Public Health Dent 1993;53:17-44.

- Brunelle JA, Carlos JP. Recent trends in dental caries in US children and the effect of water fluoridation. J Dent Res 1990; 69(Spec Iss):723-7.
- 17. Newbrun E. Current regulations and recommendations concerning water fluoridation, fluoride supplements and topical

fluoride agents. J Dent Res 1992;71:1255-65.

- Szpuner SM, Burt BA. Evaluation of appropriate use of dietary fluoride supplements in the US. Community Dent Oral Epidemiol 1992;20:148-54.
- 19. Burt BA, Eklund SA, Loesche WJ. Dental benefits of limited exposure to fluoridated water in childhood. J Dent Res 1986;65:1322-5.
- 20. Horowitz HS. The future of water systemic fluorides. J Dent Res 1990;69(Spec lss):760-4.
- 21. Horowitz AM, Frazier PJ. Promoting the use of fluorides in a community. In: Newbrun E, ed. Fluorides and dental caries—contemporary concepts for practitioners and students. 3rd ed. Springfield, IL: Charles C. Thomas, 1986:256-82.