COMMENTARY

The 2001 CDC Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States

Herschel S. Horowitz, DDS, MPH

The Centers for Disease Control and Prevention (CDC) published "Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States" in August 2001 (1). At its 2002 annual meeting in San Diego, the Section on Community and Preventive Dentistry of the American Dental Education Association sponsored a session, "New Fluoride Recommendations: Is There Adequate Evidence?" At that session, I was asked to analyze the evidence for and against the recommendations following an overview of them by Dr. Scott Presson of CDC. My presentation was excerpted from the commentary that follows.

The CDC report on recommendations for using fluoride to prevent and control dental caries in the United States is, in many ways, excellent and timely. Among its strengths, the report emphasizes that fluoride is needed throughout life to prevent and control dental decay and that use of fluoride can lead to savings of public and private resources. The recommendations include strong support for the continuation and expansion of community water fluoridation and emphasizes that the procedure is an efficient strategy to reduce inequalities of dental disease among Americans of all social and economic strata. The report also stresses the importance in caries prevention of using or being exposed frequently to small amounts of fluoride, as provided by a fluoridated water supply and brushing teeth at least twice a day with a fluoride-containing toothpaste. It accentuates the importance of monitoring fluoride intake by parents or caregivers of children younger than 6 years of age to reduce the risk of chronic overingestion of fluoride, which may increase the risk of developing enamel fluorosis, and urges that labels of bottled water products contain information on fluoride amounts or concentrations so that consumers can make informed decisions about fluoride intake. The latter is extremely important today when bottled water sales are skyrocketing.

The published report is certainly better than the working drafts I saw. I had served as one of 23 reviewers (page 2) who met in Atlanta in the late 1990s to comment on the original reviews of various fluoride modalities prepared by " ... 11 specialists in fluoride research or policy...." I felt the draft recommendations that supposedly assimilated the original reviews and the comments and papers of the reviewers were poorly done and failed to consider fairly issues raised at the meeting of reviewers. I felt so strongly about some shortcomings of the drafts prepared following the reviewers' meeting that I requested my name be deleted from the intended list of acknowledged reviewers to be included in the eventual published version of the report. The authors of the report honored my request. The final report was improved to the point where, had I seen it, I may not have asked to have my name removed from the list of reviewers.

The recommendations state clearly and unequivocally (page 1) that the "...widespread use of fluoride has been a major factor in the decline in the prevalence and severity of dental caries in the United States and other economically developed countries." The report goes on to say (page 2) that "because many fluoride modalities are effective, inexpensive, readily available, and can be used in both private and public health settings, their use is likely to continue."

The recommendations astutely point out (page 2) that because many fluoride-containing products—such as dentifrices, mouthrinses, dietary supplements and professionally applied products—have been developed since the advent of community water fluoridation in 1945, and because fluoride now is contained in small amounts in foods and beverages processed with fluoridated water, US residents have many more sources of fluoride available to them than did US residents 50 years ago.

The report emphasizes (page 2) that most fluoride modalities were tested primarily before 1980, when dental caries was more common and severe than it is today and that these methods were usually tested separately and with the assumption that each would provide the main source of administered fluoride, whereas exposures to single measures are no longer the standard. The report also states (page 2) that it focuses on the use of multiple sources of fluoride; however, this issue is skimpily addressed. Only two small paragraphs (pages 19 and 24) mention combinations of fluoride modalities; therefore, the recommendations fail to help health care providers achieve maximum protection from caries from use of combinations of fluoride, which is the usual situation today (2).

The recommendations contain an excellent description of how fluoride works to prevent and control dental decay. The relation between preeruptive or systemic exposure to fluoride and posteruptive or topical exposure is put into proper perspective, although based on some of the report's recommendations, the authors seem to put little stock in the value of preeruptive or systemic exposure to fluoride. They state (page 4) that "...laboratory and epidemiologic research ... indicates that fluoride's predominant effect is posteruptive and topical...," but they do not provide

Send correspondence to Dr. Horowitz, 6307 Herkos Court, Bethesda, MD 20817-3344. E-mail: hershhorowitz@msn.com. [J Public Health Dent 2003;63(1):3-8]

original epidemiologic evidence to support this view; their only reference in support is a statement in a textbook (3). Clinical epidemiologic data demonstrate both pre- and posteruptive caries-preventive benefits to teeth from fluoride (4-9). A recent report by Singh et al. clearly shows that preeruptive exposure to fluoride in Australian children 6–15 years old was required for a caries-prevention effect in first permanent molars and that exposure to fluoride after eruption alone did not alter caries levels significantly (9). *[Editor's note: See paper by Singh et al. pp 11-19 in this issue].* Maximal caries-preventive effects of fluoridated water were achieved by high pre- and posteruption exposure.

Several studies have reported that teeth formed in fluoridated communities or exposed to fluoride supplements preeruptively tend to be smaller and have shallower pits and fissures than teeth formed in nonfluoridated communities or not exposed preeruptively to fluoride supplements (10-12). Even if the differences are small and do not entirely explain lower caries prevalence, the very fact that measurable alterations in tooth morphology occur when there is preeruptive exposure to fluoride indicates that there must be some effect from exposure to fluoride during tooth development.

The recommendations accurately report (page 5) how dramatically dental caries has declined in the United States since the early 1970s. As an example, the report states that the prevalence of having had any dental caries among children aged 12 to 17 years dropped from 90.4 percent in 1971–74 to 67 percent in 1988–91 and, as measured by severity or mean number of decayed, missing, or filled teeth, declined from 6.2 DMFT to 2.8 DMFT during the same period. These latter figures denote a 54 percent reduction in teeth affected by caries in a relatively short interval. This substantial improvement can be attributed largely to widespread exposure to a panoply of fluoride agents and modalities. Teenagers' diets with respect to caries causation certainly did not improve during this period, inasmuch as sugar consumption increased during the interval and patterns of eating generally have evolved to frequent snacking rather than less frequent regular meals. Oral hygiene practices may have improved during this period, but the improvement would have had a greater effect on improving gingival health rather than on reduced dental decay. With so many fluoride agents known to be effective in preventing or controlling dental caries, it is disturbing to me that the CDC report takes a cautious stand on some effective fluoride modalities that discourages their use except by children at high risk of developing dental caries.

In their discussion on page 5 on risk for dental caries, the authors of the report use the often quoted statistic that, in the early 1990s, 80 percent of the dental caries in permanent teeth of US children aged 5–17 years occurred among 25 percent of those children to justify saying it is essential to be able to identify groups and persons at high risk for developing new carious lesions in order to apply appropriate and effective caries-prevention and control strategies. Yet they state that caries risk assessment is difficult because it attempts to account for complex interactions of multiple factors. They admit that no single model has emerged from research on caries risk assessment for individuals and none may be better than a dentist's perception of a patient's risk at the time of examination combined with a pertinent history. Moreover, it is likely that relatively few of the 25 percent of children with high numbers of caries lesions or at high risk of developing dental caries have ready access to appropriate and effective caries-prevention and control strategies, other than those that might be provided by public heath or community-based programs. Furthermore, some recent reports from Britain have questioned whether the majority of dental caries prevalence is always concentrated in small percentages of the population (13,14). For example, Tickle found that 80 percent of carious teeth were found in 42 percent of more than 15,000 5-year-old children in northwest England and that 81 percent of total dmft was found in the topmost ranked 74 percent of the total population (14). According to the author " ... findings shed doubt on the wisdom of a targeted approach to oral health promotion and disease prevention programmes."

The authors of the CDC report also state (page 5) that risk for dental caries decreases with adequate exposure to fluoride, a statement that undoubtedly is true. Consequently, recommendations should not discourage the use of any effective caries-prevention fluoride regimen as long as use of the regimen is safe. The document also states (page 5) that caries risk varies over time, perhaps numerous times during a lifetime. In short, I believe the section on risk for dental caries contains conflicting messages that may leave potential users of the document confused about how to assimilate the statements on risk when developing a rational caries-preventive strategy for a patient using the "inexact developing science" of risk assessment. The authors are probably correct in recommending (page 5) that, when risk classification is uncertain, it is prudent to treat a patient as high risk until a more accurate assessment can be made. They should have stated this right out, rather than go through a futile exercise of discussing risk assessment for individuals when we really don't know how to do that. As Vanobbergen et al. (15) conclude in their study of 3,303 children in an attempt to identify predominant risk factors at age 7 years that might predict caries in first permanent molars at age 10: "None of the sociodemographic and behavioral variables had enough predictive power at community level to be useful for identifying caries-susceptible children."

It was ill advised for the CDC report to have devoted as much coverage to a section on the risk of enamel fluorosis (pages 6 and 7) as to the section on risk of dental caries (pages 5 and 6). In fact, I believe the report dwells too much on the risk of fluorosis when dental caries remains a serious health problem, especially for some segments of the US population. Although there has been an increase in the prevalence and, to a lesser extent, the severity of dental fluorosis in the United States in recent years, the report correctly states that " ... most fluorosis today is of the mildest form, which affects neither cosmetic appearance nor dental function," and that " ... fluorosis is not considered a public health problem..." The report also states (page 6), again correctly, that "even in its severe form, enamel fluorosis is considered a cosmetic effect, not an adverse functional effect." Dental caries, in contrast, is a disease that can be painful, produce serious consequences to health, and often produces cosmetic consequences more se-

vere than fluorosis.

The CDC recommendations state (page 6) that the occurrence of fluorosis is most strongly associated with cumulative fluoride intake during enamel development. The selection of the word "cumulative" in this statement was unfortunate inasmuch as opponents of fluoridation and fluoride ingestion frequently describe fluoride as a cumulative poison, gradually accumulating in body tissues to toxic levels, which is incorrect. Fluorosis tends to occur from the chronic ingestion of excessive amounts of fluoride during enamel development. Chronic is defined as being of long duration, continuing or prolonged (16), and is not synonymous with cumulative.

The report states (page 6) that children 6 years of age or older are considered past the age when fluoride ingestion can cause cosmetically objectionable fluorosis because " ... only certain posterior teeth are still at a susceptible stage of enamel development, and these will not be readily visible." The authors should have specified which posterior teeth they had in mind. Are the "certain" posterior teeth third molars or maxillary second premolars in some individuals? The authors also create confusion by referring in the same paragraph (page 6) to the ages at risk to developing enamel fluorosis as being 8 years or younger and elsewhere as younger than 6 years. The CDC report stipulates (page 6) specific nine-month periods for boys (15 to 24 months of age) and girls (21 to 30 months of age) as being the most sensitive for producing dental fluorosis in maxillary central incisors. Neither of the supporting references for the statement is a systematic review (17,18) and such precision is unwarranted. In fact, Bardsen, in the discussion section of his systematic review on risk factors associated with the development of dental fluorosis in maxillary permanent central incisors, points out that fluoride may be easily released from bone (back exchanged) after cessation of fluoride intake (19). Therefore, a determination of critical risk periods for the development of dental fluorosis is complex. Slowly developing teeth, like cosmetically prominent permanent maxillary canines, may be susceptible to developing fluorosis well beyond age 6.

Mild forms of enamel fluorosis are described (page 6) as being "chalk-like," a description that might be construed inaccurately as being soft as chalk. A better adjective would have been "dull white," "whitish," or just "white."

The report's section on fluoride sources and their effects on pages 8–19 provides a good overall review and discussion of individual methods and agents for delivering fluoride. I found this section of the report to be particularly thoughtful. I have a few comments, however. The authors state (page 14), "Studies of 2–3 years duration have reported that fluoride toothpaste reduces caries experience among children by a median of 15%–30%." A median constitutes the middle value in a distribution. Therefore, 15 percent to 30 percent is not a median value; the authors probably meant a range of 15 percent to 30 percent.

In the discussion on page 12 of consumption of infant formula beyond age 10–12 months being a risk factor for enamel fluorosis, the authors should have stressed that it is the fluoridated water used to reconstitute formula with a fluoride concentrate that may contribute to the development of fluorosis in children who continue to use such products beyond 1 year of age (20). The report should have cautioned that in fluoridated areas, parents who wish to give their child formula beyond 1 year of age should use ready-to-feed varieties or dilute powdered concentrate with bottled water of low fluoride concentrations (20,21).

The fourth paragraph on page 14 contains conflicting messages by stating that use of fluoride toothpaste more frequently than once per day offers additional protection from caries; a subsequent sentence in the same paragraph states "whether increasing the number of daily brushings from two to three times a day results in lower caries experience is unclear."

The final paragraph in the section on dietary fluoride supplements (page 17) begins with a general medical maxim: "When prescribing any pharmaceutical agent, dentists and physicians should attempt to maximize benefit and minimize harm." This selection of a wise saw was a poor choice. The risk of fluorosis associated with dietary fluoride supplements is a cosmetic effect, not an adverse functional or harmful effect.

The first paragraph of the section on fluoride varnishes on page 18 contains an error; the correct concentration for sodium fluoride varnishes given in parts per million should be 22,600, not 2,600 ppm.

With respect to the quality of evidence for dental caries prevention and control used by members of the work group who reviewed the scientific literature on fluoride modalities, the report states (page 19) that "Members used their own methods for critically analyzing articles" and "A formal protocol for duplicate review was not followed." It is rather surprising that CDC did not use systematic reviews, in which strict inclusion criteria are established for individual studies to determine their eligibility for consideration, for this important document. When CDC's review began, systematic reviews already were considered *de rigueur* for important, comprehensive assessments of the effectiveness of preventive or treatment regimens.

The report states (page 19) that the quality of evidence for each fluoride modality (delivery method) was graded on an ordinal scale, using an adaptation of the grading system for determining the quality of evidence of the US Preventive Services Task Force. Members of the work group " ... collectively agreed on the grade reflecting the quality of evidence for each fluoride modality." This methodology has several shortcomings. Most importantly, despite the scientific qualifications of the reviewers, individual biases or prejudgments of the reviewers (and we all have them) were bound to influence the grading to some degree. Moreover, the grading was for the entire modality without consideration of the quality of individual studies. Because strict inclusion criteria on eligibility for review was not used, individual studies that might not have been deemed suitable for review were, in fact, included in the reviewers' papers and were bound to have influenced each reviewer's and the group's conclusions regarding the quality of evidence for each fluoride modality.

With respect to attempts to blind examiners in evaluations of the cariostatic effects of community water fluoridation, it is not clear to me why examining children from test and control communities in a neutral third site or using radiographs of teeth without

revealing where the subjects live does not, in the authors' opinion, fully resolve the issue (first paragraph, page 20).

In addition to a quality of evidence grade, a strength of evidence code was assigned by the work group to each fluoride modality, based on perceived considerations of effect on dental caries, its association with enamel fluorosis, and its cost effectiveness (page 24). I have comments about the grades that were assigned to some of the specific fluoride modalities. School water fluoridation was assigned a relatively low score of II-3 in Table 4 (page 25), indicating that evidence was obtained from cross-sectional comparisons between times and places, studies with historical controls or dramatic results in uncontrolled experiments, and its strength of evidence was graded as C, indicating that school water fluoridation had not been adequately tested or that some studies support it and some oppose it. I believe this is an unduly harsh and low recommendation for school water fluoridation. At least four studies have shown sizable benefits over lengthy periods of time from consuming fluoridated water at school at concentrations of fluoride ranging from about three to seven times the optimum used for community water fluoridation in the respective areas (22-25). True, these studies were not done blindly and were cross-sectional comparisons between times and had no concurrent controls; however, this also is true of most studies of community water fluoridation, which received a much higher quality of evidence score (II-1). Three of the four school water fluoridation studies were done in the 1950s and 1960s, before there was any evidence of a secular decline in dental caries prevalence among school-aged children in the United States (22-24). So, it is unlikely that the measured benefits of school fluoridation in these studies, about 40 percent, were confounded by secular declines in dental caries.

Only one study has reported little or no effectiveness from school water fluoridation (26). This study was conducted in the 1990s, when the secular decline in caries in school-aged children was well established. This study was reported only as an abstract in 1995; a full report has not been published in a peer-reviewed journal. Considering all the research that has been done. I don't think it was fair to have coded school water fluoridation as having lack of evidence or mixed evidence in grading the strength of evidence for the procedure.

I am not suggesting school water fluoridation should have been recommended by CDC as a feasible or practical fluoride method. There are many practical or logistical reasons for not recommending school water fluoridation programs today, such as high costs, the need for engineering expertise in setting up and repairing equipment, and the growing trend of schools functioning as preschool and day care programs. As I see it, school water fluoridation has been deemed to have limited appropriateness (page 26) for the wrong reasons.

I also question the grading of quality of evidence (II-3) and strength of the recommendation (C) for dietary fluoride supplements for children younger than 6 years of age (Table 4). The authors of the report cite problems in the studies of fluoride supplements in preschool-aged children of self-selection of subjects into test and control groups, high attrition rates, and nonblinded examiners (page 21). Despite these serious flaws, measured benefits against dental caries in these studies were very high, often exceeding protection achieved in evaluations of water fluoridation. Higher protection from dietary fluoride supplements has been attributed to the delivery of a precise dosage rather than the variable exposure that occurs with water fluoridation (27).

Considering the low scores for quality of evidence and strength of the recommendation of dietary fluoride supplements for children younger than 6 years of age, it is paradoxical that they received the highest grade for those categories for children aged 6 to 16 years. The authors recommend fluoride tablets and lozenges be chewed or sucked for 1 to 2 minutes to maximize the topical effects (page 16). They even suggest, "Fluoride supplements might be beneficial among adults who have limitations with toothbrushing ...," although, they continue, data are lacking to support such a recommendation.

Why are topical effects not important for the primary teeth of children younger than 6? Moreover, the authors point out (page 16), "Several studies have reported that fluoride supplements taken by infants and children before their [permanent] teeth erupt reduce the prevalence and severity of caries in [those] teeth...." Surely this statement supports a preeruptive fluoride benefit, which they deemphasize in a previous section of the report on "How Fluoride Prevents and Controls Dental Caries" (pages 3 and 4). It is the authors' apparent concern about the association of the use of dietary fluoride supplements by children younger than 6 years of age with dental fluorosis that has led them not to recommend these supplements for children younger than 6 years of age. They point out (page 16) that the recommended dosage schedule for dietary fluoride supplements was "markedly reduced" in 1994, especially for preschool-aged children. At the same time, they prefer to be cautious about recommending fluoride supplements for this age group, rather than waiting to see what impact the lower dosage has on reducing the prevalence of dental fluorosis, although measuring the effect on fluorosis of a change in a single modality will be difficult, if not impossible, to ascertain.

Table 4 in the CDC recommendations (page 25) contains a column labeled "Target Population." This column contains a footnote that states: "Quality of evidence for targeting some modalities to persons at high risk is grade III (i.e., representing the opinion of respected authorities) and is based on considerations of cost-effectiveness that were not indicated in the studies establishing efficacy or effectiveness." Does anyone, including the authors, really understand this statement?

A designation of high risk is entered as the target population for fluoride mouthrinses, fluoride gels, fluoride varnishes, and fluoride supplements for all age groups. The report states that a dental care or health care provider must consider a person's or group's risk for dental caries, current use of other fluoride sources, and risk of enamel fluorosis in deciding on the use of various fluoride interventions (page 25). The lengthy subscript to Table 4 discusses factors that put populations and individuals at high risk for dental caries. Although I cannot repeat them all, these factors include: low socioeconomic status, low parental edu-

cation, those with high caries experience in older siblings or caregivers, high levels of cariogenic bacterial infection, reduced salivary flow, and low salivary buffering capacity. Assessing and assimilating this information places a difficult and perhaps unrealistic burden on caregivers. Moreover, the subscript continues by stating that risk can increase when combined with dietary practices conducive to dental caries and decreases with adequate exposure to fluoride. This attempt to clarify the designation of "high risk" raises the rhetorical question: what's a poor caregiver to do? I find this attempt to triage patients by risk assessment is overly complex for a report purporting (page 1) to contain recommendations to "...guide dental and other health care providers, public health officials, policy makers, and the public in the use of fluoride to achieve maximum protection against dental caries...."

In the section of the recommendations on Public Health and Clinical Practice, a subsection titled "Judiciously Prescribe Fluoride Supplements" states (page 26) that they can be prescribed for children at high risk for dental caries. Dentists, physicians, and other health care providers are advised to weigh the risk for caries and the potential for enamel fluorosis before recommending these supplements. Because caries risk assessment is such an imprecise science and impractical and complex to interpret and implement, it is unlikely that practitioners can ascertain who is at high risk. If they wait until dental caries develops before prescribing dietary fluoride supplements, the damage to varying degrees already has been done. In the meantime, children who consume water with insufficient concentrations of fluoride will have been deprived of regular systemic and topical exposures to fluoride to protect their developing primary and permanent teeth and already erupted primary teeth from developing caries. How does one go about intelligently informing parents and caregivers about protection against dental caries and the possibility of enamel fluorosis when discussing the use of dietary fluoride supplements (page 27)? Should parents be asked: "Do you want to reduce the risk of your child's having a disease that produces holes in his or her teeth, possible pain, costs money to place a filling, and frequently requires larger and larger fillings throughout life or to increase the risk of your child's developing some teeth that may have a few whitish flecks on them?" My question is simplistic, but CDC's advice on informing parents about relative risks of caries and enamel fluorosis is complex and creates an imponderable dilemma for parents and care providers.

Dentists, pediatricians, and other physicians have prescribed dietary fluoride supplements for many years as an alternative source of systemic and topical fluoride for children who live in areas with fluoride-deficient water supplies. The CDC's tepid recommendations and cautionary statements for fluoride supplements, especially for preschool-aged children, may diminish their use in the United States and probably in other countries that rely on CDC recommendations in making their own decisions for public health programs.

A recent report from Norway addresses the question of what may ensue when the use of dietary fluoride supplements declines. Birkeland and Haugejorden reported that the caries prevalence of 5-year-olds in 2000 increased to 38.9 percent from 30.4 percent in 1997 after more restrictive recommendations for the use of fluoride tablets were adopted for public dental services in 1996 (28). Sales of fluoride tablets declined by almost 50 percent during the interval. The sale of fluoride tablets had a significant effect ($P<.03$) on caries prevalence among 5-year-olds when controlling for other variables. The authors concluded that there is a need for reassessment of the caries-preventive programs for children in Norway.

I believe the use of fluoride supplements in appropriate areas for Head Start and other child development programs and day care centers can provide a valuable, regular source of fluoride for caries prevention. It would indeed be unfortunate if their use in such programs is reduced because of the position taken on them in the CDC recommendations. Moreover, there is also the danger that manufacturers of dietary fluoride supplements may discontinue marketing these products because demand for them may dwindle to the point where their sale is no longer economically feasible because they are recommended only for children at high risk for developing dental caries. Their absence from the caries-preventive armamentarium would be a great loss.

In summary, although the CDC recommendations for using fluoride to prevent and control dental caries contain much valuable information for dental and other health care providers, public health officials, policy makers, manufacturers of fluoride-containing products, and the public on the use of fluoride, the report overemphasizes the risks of developing dental fluorosis from the injudicious use of fluoride rather than the benefits that have occurred and should continue to occur from the proper use of various fluoride modalities. The report should have emphasized the need for greater, more effective education of its target audiences (29-32) to reduce the risk of dental fluorosis, particularly from the use of fluoride toothpastes and dietary fluoride supplements, rather than being so apprehensive about a cosmetic condition that is an alternative to a disease.

Acknowledgments

I thank Stanley Heifetz, Alice Horowitz, and Ernest Newbrun for reviewing and providing helpful comments on drafts of this commentary.

References

1. Centers for Disease Control and Prevention. Recommendations for using fluoride to prevent and control dental caries in the United States. Morbid Mortal Weekly Rev MMWR 2001;50(RR-14):1-42.
2. Horowitz HS. Combinations of caries preventive agents and procedures. J Dent Res 1980;59:2183-9.
3. Clarkson BH, Fejerskov O, Ekstrand J, Burt BA. Rational use of fluorides in caries control. In: Fejerskov O, Ekstrand J, Burt BA, eds. Fluorides in dentistry. 2nd ed. Copenhagen: Munksgaard, 1996:347-57.
4. Marthaler TM. Fluoride supplements for systemic effects in caries prevention. In: Johansen E, Taves DR, Olsen TO, eds. Continuing evaluation of the use of fluorides. Boulder, Co: Westview (American Association for the Advancement of Science Selected Symposium no 11), 1979: 33-59.
5. Groeneveld A, Van Eck AAMJ, Backer Dirks O. Fluoride in caries prevention: is the effect pre- or posteruptive? J Dent Res 1990;69(Spec Iss):751-5.
6. Murray JJ. Efficacy of preventive agents for dental caries. Systemic fluorides: water fluoridation. Caries Res 1993; 27(Suppl 1):2-8.
7. Van Eck AAMJ. Pre- and posteruptive effect of fluoridated drinking water on dental caries experience (thesis), University of Utrecht, 1987 (NIPG-TNO no

87021).
8. Backer Dirks O, Houwink B, Kwant GW. The results of 6 1/2 years of artificial fluoridation in the Netherlands—the Tiel Culenborg experiment. Arch Oral Biol 1961;5:284-300.
9. Singh KA, Spencer AJ, Armfield JM. Relative effects of pre- and posteruption water fluoride caries experience of permanent first molars. J Public Health Dent 2003;63:11-19.
10. Lovius BBJ, Goose DH. The effect of fluoridation of the water on tooth morphology. Br Dent J 1969;127:322-4.
11. Simpson WJ, Castaldi CR. A study of crown morphology of newly erupted first permanent molars in Wetaskium, Alberta (optimum fluoridated) and Camrose, Alberta (low fluoride). Odont Rev 1969;20:1-14.
12. Aasenden R, Peeples TC. Effects of fluoride supplementation from birth on human deciduous and permanent teeth. Arch Oral Biol 1974;19:321-6.
13. Tickle M, Brown PJB, Blinkhorn AS, Jenner AM. Comparing the ability of different area measures of socioeconomic status to segment a population according to caries prevalence. Community Dent Health 2000;17:138-44.
14. Tickle M. The 80:20 phenomenon: help or hindrance to planning caries prevention programmes? Community Dent Health 2002;19:39-42.
15. Vanobbergen J, Martens L, Lesaffre E, Bogaerts K, Declerck D. The value of a baseline caries risk assessment model in the primary dentition for the prediction of caries incidence in the permanent dentition. Caries Res 2001;35:442-50.
16. The American dictionary of the English language. Morris W, ed. New York: American Heritage Publishing Co./ Houghton Mifflin, 1969:240.
17. DenBesten PK, Thariani H. Biological mechanisms of fluorosis and level and timing of systemic exposure to fluoride with respect to fluorosis. J Dent Res 1992; 71:1238-43.
18. Evans RW, Stamm JW. Dental fluorosis following downward adjustment of fluoride in drinking water. J Public Health Dent 1991;51:91-8.
19. Bardsen A. "Risk periods" associated with the development of dental fluorosis in maxillary permanent central incisors: a meta-analysis. Acta Odontol Scand 1999;57:247-56.
20. Pendrys DG, Katz RV. Risk for enamel fluorosis associated with fluoride supplementation, infant formula, and fluoride dentifrice use. Am J Epidemiol 1989; 130:1199-208.
21. Horowitz HS. Proper use of fluoride products in fluoridated communities. Lancet 1999;353:1462.
22. Horowitz HS, Law FE, Pritzker T. Effect of school water fluoridation on dental caries, St. Thomas, V.I. Public Health Rep 1965;80:381-8.
23. Horowitz HS, Heifetz SB, Law FE, Driscoll WS. School fluoridation studies in Elk Lake, Pennsylvania, and Pike County Kentucky—results after eight years. Am J Public Health 1968;58:2240-50.
24. Horowitz HS, Heifetz SB, Law FE. Effect of school water fluoridation on dental caries: final results in Elk Lake, PA, after 12 years. J Am Dent Assoc 1972;84:832-8.
25. Heifetz SB, Horowitz HS, Brunelle JA. Effect of school water fluoridation on dental caries: results in Seagrove, NC, after 12 years. J Am Dent Assoc 1983;106: 334-7.
26. King RS, Iafolla TJ, Rozier RG, Satterfield WC, Spratt CJ. Effectiveness of school water fluoridation and fluoride mouthrinses. J Dent Res 1995;74(Spec Iss):192.
27. Driscoll WS, Horowitz HS. Dosage recommendations for dietary fluoride supplements. Am J Dis Child 1979;133:683-4.
28. Birkeland JM, Haugejorden O. Reversal of the caries decline among Norwegian children. Caries Res 2002;36:174.
29. Horowitz AM. Ways to improve/increase appropriate use of dietary fluorides. ASDC J Dent Child 1985;2:269-77.
30. Horowitz AM. How pharmacists can help in appropriate use of fluoride supplements. Pharm Times 1985;51:28-33.
31. Horowitz AM. The public's oral health: gaps between what we know and what we do. Adv Dent Sci 1995;9:91-5.
32. Horowitz AM. Challenges of and strategies for changing prescribing practices of health care providers. J Public Health Dent 1999;59:275-81.