

The safety and effectiveness of fluoridation of community drinking water supplies

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Grand Rapids, Michigan, was the first city in the United States to control the amount of fluoride in its water supply. It began to fluoridate its water in January 1945. Newburgh, New York, and Brantford, Ontario, Canada also began to fluoridate their water in 1945. These are some of the early, classic studies of fluoridation.

There were dramatic reductions in the prevalence of dental caries in these three communities that approximated 50 to 60 percent or more. Murray and Rugg-Gunn, British epidemiologists, compiled results of 94 different studies in 20 different countries in 1980, and reported that the mode of reduction in caries in deciduous or baby teeth was between 40 and 50 percent and in permanent teeth between 50 and 60 percent.

The dramatic results of early studies of fluoridation led to its widespread adoption as a widely used public health method for the prevention of dental decay. Some of the attributes of community water fluoridation that make it an ideal public health method are that it is the least expensive and most effective way for a community to reduce dental decay. It is eminently safe: probably fluoride has been studied more than any other element during the last 45 years or longer, if one considers the epidemiologic studies that preceded the initial fluoridation experiments.

One reason there has been so much research on the safety of fluorides is that there have been so many allegations against fluoridation and fluoride over the years, and each, in turn, has led to additional studies to reaffirm the benefits and safety of the procedure, as the National Cancer Institute of the U.S. National Institutes of Health

has repeatedly done to show that it is not associated with cancers.

Fluoridation is a very equitable procedure. It reaches everyone regardless of age, income or educational background. It is a very fair way of bringing benefits to a community that requires no cooperative effort on the part of beneficiaries. They don't have to go to the dentist. They don't have to take anything. Just by living in a community, drinking when they get thirsty, eating when get hungry foods that have been prepared with the water means that residents of fluoridated communities automatically benefit. The benefits continue for a lifetime, as long as fluoridate water continues to be consumed, and several studies have shown the cost of dental care are reduce considerably after fluoridation has been in place for a number of years.

Fluoridation benefits all types of teeth and all types of tooth surfaces, but it is most effective in the smooth surfaces of teeth rather than the surfaces that have pits and fissures, such as the biting surfaces of posterior teeth that have irregularities. Many studies have show a much more profound effect on the smooth surfaces between teeth where they touch one another or on the smooth buccal or lingual surfaces of a tooth than on the biting surfaces or those that have little developmental pits.

When fluoridation was initiated there was a great deal of emphasis on the benefits to children, and at that point in time, it was really thought that fluoridation worked essentially systemically, that it was important to get fluoride incorporated into developing teeth as they formed in the jaw because those teeth would come into the mouth with bigger fluoride crystals that were more resistant to decay. That is, in fact, one mechanism by which fluoride works but it also, works ambiently and topically on teeth that are already erupted into the mouth. Each time we

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consume refined carbohydrates, a demineralization of tooth enamel occurs. Remineralization, the repair that occurs to teeth after we consume refined carbohydrates, is a process that is very important in caries prevention, and fluoride is very important in facilitating this repair process that occurs in between having cariogenic challenges.

Some of the definitive data that have been used to show this topical effect of fluoride includes a study by Hardwick in England. He studied a group of 12-year-old children who essentially had all their permanent teeth, other than third molars, already erupted when fluoridation began in a town and used children of the same age in a control community that was not about to fluoridate its water. He followed children in the respective communities for a 4-year period. Any difference in new decay that occurred between the two groups of children had to be attributed to topically applied effect of drinking fluoridate water. When the children were 16 years old, there was a 27 percent difference in new dental decay between fluoridate and non-fluoridate communities, a savings of about 2-1/2 decayed, missing and filled surfaces (DMFS) per child from the topical effect of drinking fluoridated water.

It has been alleged by opponents to fluoridation, that the procedure does not really prevent decay, but merely delays the onset of decay. This is eminently not true. Data from several epidemiologic studies refute this claim. In Colorado, a classic study by Russell and Elvove showed that adults between 20 and 45 years of age experienced sizeable differences in the prevalence of dental caries in all age groups between a community with natural fluoride in the water and a community essentially with only trace amounts of fluoride in the water. The advantage to adults in the fluoridate community approximated 60 percent.

Recent findings of the effect on root surface decay, which is being recognized as a very serious problem among older adults today, are very exciting. As we age, the gingiva recedes, exposing root surfaces, which are susceptible to decay. Stamm and Banting, in two Canadian communities, showed that the percentage of people with root surface decay in all age groups, from 20 up through 60-plus was considerably lower in a community with natural fluoride in the water than in a community with only trace amounts of fluoride in the water. Other studies in adults older than 60 show reductions in the neighborhood of 17 to 35 percent differences in caries between fluoridated and non-fluoridated areas. Currently, about 63 percent of the US population live in fluoridated communities or in areas that naturally contain 0.7 parts per million (ppm) of fluoride or more in water. Actually, the percentage is a little bigger than that because recently a large city in the United States, Phoenix, Arizona, began to fluoridate its water.

The results of the most recent national survey of United States schoolchildren done by the National Institute of Dental Research (NIDR) in the 1986-87 school year showed

that the percentage of children who are caries-free, who have no decay in their permanent teeth, is 50 percent. Half of all U.S. schoolchildren today are free of dental caries. Obviously, there is a difference by age; younger school children have very few permanent teeth and these have not been in the mouth for a long time, and thus, these children have very high percentages of caries-free dentitions. But for the older children, age 1, the percentage without decay drops to a fairly low level. Overall, however, one-half of the children in the United States today who are in school are free of dental decay in their permanent teeth.

There have been three national, representative survey of U.S. schoolchildren using the same examination techniques and methods of sampling. The first survey was done in the early 1970s by the National Center for Health Statistics. The National Institute of Dental Research did surveys in 1979-1980 and then again in 1986-87. There has been a clear reduction in dental decay in the United States in the last 20 years. The overall reduction that occurred in the two intervals is about 35 percent each time. Dental decay among children has gone down dramatically in the United States.

Studies done only by the NIDR using the same techniques, some of which I was involved with, show the dramatic reduction that has occurred in school-age populations from the late 1950s to 1986-87, dropping from about 13-1/2 DMFS per child down to over 3 DMFS during that interval. Approximate tooth surface decay, the surfaces of teeth that touch one another, has dropped dramatically. As I indicated, fluoride is most effective on those surfaces.

How effective is fluoridation today? The procedure used to reduce caries by 50 to 60 percent. Study after study showed that amount of benefit. The results of the 1986-87 survey of US school children showed that those who had a life-long-history of living in a fluoridated area as opposed to those who lived all their lives in a low fluoride area had 23 percent fewer cavities in their primary teeth. In permanent teeth, the difference between fluoridated and non-fluoridated areas was only 18 percent. Does that mean that fluoridation is no longer effective? No, it does not. It means that other things are happening in the United States, which have contributed to reducing dental decay in both fluoridate and non-fluoridated areas.

Although about 63 percent of the U.S. population uses fluoridated water, the procedure is not equally distributed across the country. Fluoridate water is consumed largely in the upper Midwest and the Southeast; in the Western part of our country, there are low percentages of the population drinking fluoridated water. When the results of the 1986-87 NIDR survey were analyzed by region of the country, it was found that in regions where the percentages of the population drinking fluoridated water were high, little or no differences in dental decay existed between children living in fluoridated areas and those living in non-fluoridated areas. However, in the western parts of the country with

very little fluoridation, the difference in caries between fluoridated and non-fluoridated communities was sizeable. If one plots percentage differences in dental caries between fluoridated and non-fluoridated areas, according to the regional percentage of the population using fluoridated water, a fairly clean direct trend line exists between effectiveness and low percentage of the population drinking fluoridated water.

Why should that be? The principal reason for the decline in caries is that we have so many vehicles for delivering fluoride to people these days: community fluoridation, school water fluoridation, dietary fluoride supplements used at home or in school programs, fluoride mouth rinses which one can buy over-the-counter or are used in school programs in higher concentrations, fluoride toothpastes, which are ubiquitous in our country and professionally applied fluoride. All of these have been shown in dozens of studies to reduce the prevalence or incidence of dental decay and all are used widely in the United States.

In fact, the 1986-87 NIDR survey obtained information on the use of fluoride tablets or drops, fluoride treatment in dental offices and fluoride regimens in school programs in fluoridated and non-fluoridated areas. The findings showed that more children use or receive these alternative or supplementary preventive procedures in low water fluoride areas than in fluoridated areas, which tends to reduce the difference in dental caries prevalence between the two types of communities.

In addition, a disseminated or indirect effect occurs with community water fluoridation. Children and adults living in non-fluoride areas consume soft drink and eat foods that have been processed in nearby fluoridated communities, and thus, derive an indirect or disseminated benefit from fluoridation. This phenomenon helps to explain why there is less difference in caries between fluoridated and non-fluoridated communities in highly fluoridated regions of the country than in regions of the country with little fluoridation.

Fluoridation is practiced most in the bigger cities of the United States. With Phoenix being added, we now have 42 of the 50 most populous cities in the United States with community water fluoridation. These 50 cities have a

collective population of more than 40 million and about 33 million of them are consuming fluoridated water.

Soft-drink bottling plants and food processing facilities tend to be located in larger communities, which tend to be fluoridated, and thus, most processed foods and beverages contain therapeutic concentrations of fluoride. Use of these products benefits indirectly those in low fluoride areas.

After reviewing the literature, Newbrun recently estimated the most likely benefits one can expect from the implementation of fluoridation in the USA; although still substantial and cost-effective, the benefits no longer reach 50 to 60 percent reductions in dental decay. Perhaps half that degree of protection can be achieved today because of the factors I have discussed in this paper.

In other countries where not as many alternative fluoride vehicles exist, there is no reason to believe that fluoridation will not be as effective as it was in the past in the United States. It has been suggested by some opponents to fluoridations that we don't need fluoridation any more, and there has even been a sprinkling of such comments from researchers in other countries where there is no fluoridation and where they rely on fluoride toothpaste alone to get reductions in decay. Why don't we eliminate fluoridation and depend on these alternative vehicles? A very important study relevant to that question was reported by Stephen not too long ago on the discontinuation of fluoridation in Wick, Scotland, where he found that 5 years after fluoridation was discontinued there was a 27 percent increase in the prevalence of caries in primary teeth of 5 and 6 year old children, and 10 percent fewer children were free of dental decay in their primary dentition. Stephen made this important comment in the discussion of his paper, "that to consider eliminating fluoridation today, based on these findings, is really not thinkable."

I want to emphasize in my closing comments that fluoridation benefits everyone in a community, regardless of their socioeconomic levels, their educational achievement, their individual motivation to do something about their health, the availability of dental services and their ability to afford them. Fluoridation is the least expensive and most equitable and effective way to provide fluoride to large groups of people.