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Public Health Service Report on Fluoride Benefits and Risks

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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Public Health Service Report on Fluoride Benefits and Risks

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Preface

This report, "Public Health Service Report on Fluoride Benefits and Risks" is a summary of the findings, conclusions, and recommendations of *Review of Fluoride Benefits and Risks: Report of the Ad Hoc Subcommittee on Fluoride of the Committee to Coordinate Environmental Health and Related Programs,* published in February 1991. The full report was prepared by an ad hoc subcommittee of the United States Public Health Service's Committee to Coordinate Environmental Health and Related Programs (CCEHRP) at the request of the Assistant Secretary for Health. The full report can be obtained from the Public Health Service, Department of Health and Human Services.

Public Health Service Report on Fluoride Benefits and Risks

BACKGROUND

In the early part of this century, researchers observed that persons with "mottled teeth," or dental fluorosis, experienced fewer dental caries than persons without that pattern of tooth discoloration. Naturally occurring fluoride in the drinking water was identified later as being responsible for this effect on tooth enamel. Community studies conducted in the 1940s established that as the level of natural fluoride in the drinking water increased, the prevalence of dental caries declined. These studies led to the public health practice of adjusting fluoride concentration levels in fluoride-deficient drinking water supplies to bring the total level of fluoride to approximately 1 part per million (ppm). The optimal range of community water fluoridation (optimal with respect to reducing dental caries and minimizing the risk of dental fluorosis) has been determined previously by the United States Public Health Service to be 0.7-1.2 ppm.

Controversy over the purported adverse health effects of fluoride has been associated with community water fluoridation programs since widespread implementation began in the 1950s. This controversy is related in part to evidence that exposure to fluoride in sufficiently high doses can produce toxicity in animals and humans. In the 1970s, a limited number of studies reported increased cancer mortality in cities with adjusted water fluoridation relative to cities without adjusted water fluoridation programs. Although this claim subsequently was refuted by numerous investigators, the concern over a possible association between cancer and water fluoridation prompted the National Toxicology Program (NTP) of the United States Public Health Service (PHS) to conduct a long-term study of the toxicity and carcinogenicity of sodium fluoride exposure in rodents. This study employed a standard rat and mouse bioassay that has been useful in evaluating the potential carcinogenicity or toxicity of numerous chemicals.

In the spring of 1990, NTP released the findings of its fluoride study. Although the study found no evidence of carcinogenicity in female rats or in mice of either sex, it did find "equivocal evidence" of carcinogenicity based on a small number of osteosarcomas in male rats in the medium- and high-dosed exposure groups. The term "equivocal evidence" is one of five standardized categories used by NTP to describe the strength of evidence of carcinogenicity of individual experiments. The category "equivocal evidence" is used to describe the results of studies in which an association between administration of a chemical and a particular tumor response is uncertain.

ASSESSMENT OF THE HEALTH BENEFITS OF FLUORIDE

The PHS report concluded that fluoride has substantial benefits in the prevention of dental caries. Numerous studies have established a clear causal relation between use of fluoridated water and the prevention of dental caries. Although the occurrence

of caries can be reduced through the use of fluoridated toothpaste and mouth rinses, professional fluoride treatment, and fluoride dietary supplements, fluoridation of water is the most cost-effective method and provides the greatest benefit to those who can least afford preventive and restorative dentistry. In the 1940s, children in communities with fluoridated drinking water experienced reductions in caries experience (as measured by decayed, missing, and filled tooth scores) of about 60% relative to those for persons living in nonfluoridated* communities. Although studies conducted in the 1980s continued to demonstrate that caries scores are lower in fluoridated areas, studies show that the differences in caries scores between fluoridated and nonfluoridated areas have declined to 20%-40%. This apparent change may reflect the presence and use—in nonfluoridated areas—of fluoride in beverages, food, dental products, and dietary supplements.

ASSESSMENT OF THE HEALTH RISKS OF FLUORIDE

The PHS Subcommittee undertook a comprehensive review of the possible association between fluoride exposure and various adverse health outcomes. The report concluded that there is a lack of evidence of associations between levels of fluoride in water and birth defects or problems of the gastrointestinal, genito-urinary, and respiratory systems. Three possible health effects–cancer, effects on bone, and dental fluorosis–were addressed in greater detail.

Cancer

The two approaches used to determine whether there is an association between exposure to fluoridated water and cancer are: a) carcinogenicity studies of rodents and b) epidemiologic analyses to compare cancer incidence and mortality rates in communities with fluoridated water and in those with negligible levels of fluoride in drinking water.

Animal Studies

The NTP study found that rates of osteosarcomas rose as the dose of sodium fluoride exposure for male rats increased, but not for female rats or for mice of either gender. These findings were interpreted as "equivocal evidence" of carcinogenicity for male rats but no evidence of carcinogenicity for the other gender/species tested. In another recent carcinogenicity study conducted by Maurer, Cheng, Boysen, and Anderson and sponsored by Procter and Gamble (P&G), no evidence was found for an association between the development of malignant tumors and exposure to sodium fluoride in rodents of either gender. Taken together, the NTP and P&G studies fail to establish an association between fluoride and cancer.

Epidemiologic Studies

The ad hoc subcommittee of the Committee to Coordinate Environmental Health and Related Programs reviewed the results from numerous epidemiologic studies of the relation between exposure to fluoridated water and cancer that have been

*Nonfluoridated areas are those with community water supplies that have fluoride concentrations below the optimum level (in the range of 0.7-1.2 ppm, based on the annual average of the maximum daily air temperature), generally below 0.3 ppm.

conducted during the last 40 years. In addition to the review of these studies, the Subcommittee reviewed the findings of a recent study from the National Cancer Institute (NCI), which updated and expanded an earlier county-specific analysis of cancer mortality in the United States in relation to water fluoridation. This study evaluated cancer mortality data and examined patterns of cancer incidence from 1973 through 1987 in the Surveillance, Epidemiology and End Results (SEER) program cancer registries. The SEER registries were used to obtain data on incidence for all types of cancer, with special emphasis placed on trends in osteosarcomas.

The NCI study identified no trends in cancer risk that could be attributed to the introduction of fluoride into drinking water. There were no substantial differences in cancer mortality rates among persons who lived in counties that had initiated water fluoridation and those in persons who lived in counties without water fluoridation. Similarly, there was no apparent relation between introduction and duration of fluoridation and the incidence of cancer, including bone and joint cancer and the subset of osteosarcomas.

The NCI also conducted a more detailed evaluation of osteosarcomas using nationwide age-adjusted incidence from the entire SEER database for the years 1973-1987. During this time, the annual incidence of osteosarcoma among males <20 years of age increased from 3.6 cases/10^6 population to 5.5 cases/10^6 population. The incidence among females decreased slightly during the same period (from 3.8 cases/10^6 population to 3.7 cases/10^6 population). Although the increase in rates of osteosarcoma for males during this period was greater in fluoridated than nonfluoridated areas, extensive analyses revealed that these patterns were unrelated to either the introduction or duration of fluoridation. Consequently, the NCI report concluded that, while the explanation for the increase in rates of osteosarcoma among young males is unknown, it is not due to exposure to water fluoridation. Both this report and the reports from previous international expert panels which have reviewed earlier data concluded that there is no credible evidence of any association between the risk of cancer and exposure to either natural or adjusted fluoride in drinking water.

Effects on Bone

Although some epidemiologic studies have suggested that the incidence of certain types of bone fractures may be higher in some communities with either naturally high or adjusted fluoride levels, other studies have not detected increased incidence of bone fractures. However, a variety of potentially confounding factors must be examined to assess whether there is association between exposure to fluoride and bone fractures.

Fluoride has a complex dose-related action on bone. Although crippling skeletal fluorosis is more common in parts of the world with high natural fluoride (>10 ppm) levels in drinking water, its occurrence is affected by a variety of factors, including nutritional deficiencies, impaired renal function, and age at exposure. Human crippling skeletal fluorosis is endemic in several countries of the world, but is extremely rare in the United States.

Dental Fluorosis

Although the precise mechanism that causes dental fluorosis is unknown, the likelihood of dental fluorosis is related directly to the level of fluoride exposure during

tooth development. The clinical spectrum of dental fluorosis varies from symmetrical whitish areas on teeth (very mild) to secondary, extrinsic, brownish discoloration and varying degrees of pitting of the enamel (severe dental fluorosis). Among children, the prevalence of moderate and severe forms of dental fluorosis is estimated to be 1.3% nationally. Although fluorosis has historically been considered to be a cosmetic problem, these forms of dental fluorosis do not produce adverse dental health effects, such as tooth loss or impaired tooth function.

In the 1940s and 1950s, the major sources of fluoride were from drinking water and food. Since then, additional sources of fluoride have become available, including processed beverages and food, dental products containing fluoride (e.g., toothpastes and mouth rinses), and fluoride dietary supplements. Inappropriate use of these products can substantially increase total fluoride intake.

In the 1940s, approximately 10% of the population had fluorosis when the concentration of fluoride found naturally in the drinking water was about 1 ppm. Since the 1950s, in nonfluoridated areas, the total prevalence of dental fluorosis has clearly increased. During the same period, in areas where water fluoride concentrations have remained in the optimal range (about 1 ppm fluoride), the total prevalence of dental fluorosis may have increased. Increases in the prevalence of dental fluorosis suggest that total fluoride exposure is increasing. Because dental fluorosis does not compromise oral health or tooth function, an increase in dental fluorosis does not represent a public health concern; however, it indicates that total fluoride exposure may be higher than that necessary to prevent tooth decay. In general, prudent public health practice dictates using no more than the amount necessary to achieve a desired effect.

RESEARCH AND POLICY RECOMMENDATIONS

The report of the PHS Subcommittee includes a variety of recommendations regarding health policy and research about the risks and benefits of fluoride. The policy implications pertain to federal, state, and local health agencies concerned with fluoridation of community water supplies. The research recommendations on both the benefits and risks of fluorides provide direction and scope to investigators and agencies concerned with these aspects of exposure of populations to water fluoridation and fluoride-containing products.

Policy Recommendations

- The PHS should continue to recommend the use of fluoride to prevent dental caries.
- The PHS should continue to support optimal fluoridation (i.e., 0.7-1.2 ppm) of drinking water.
- The PHS should sponsor scientific conferences to assess both the optimal level of total fluoride exposure from all sources combined and the appropriate usage of fluoride-containing dental products in order to achieve the benefits of reduced dental caries and to minimize the risk of dental fluorosis.
- In accordance with prudent health practice of limiting exposure to no more than that necessary to achieve a desired effect, health professionals and the public

should avoid excessive and inappropriate exposure to fluoride (e.g., health professionals should prescribe fluoride dietary supplements only when the fluoride level of the home water supply is known to be deficient. Parents should educate young children to minimize swallowing of fluoridated toothpaste and to use only small amounts of toothpaste on the brush).

- State health departments and drinking-water programs should continue to inform physicians, dentists, and communities about the fluoridation status of drinking water to enable the determination for the need for water fluoridation or for supplemental forms of fluoride.
- The U.S. Environmental Protection Agency (EPA) should review its regulations concerning naturally occurring fluoride in drinking water on the basis of the outcome of the recommended scientific conference(s) and the information in this report.
- The FDA should review the labeling required for toothpaste and other fluoride-containing products to ensure that information is sufficient to enable the public to make informed decisions about their use, especially for young children (i.e., those <6 years of age).
- Manufacturers of toothpaste should be encouraged to clearly communicate the fluoride levels in their products. Manufacturers should determine whether toothpaste can be dispensed in a dose-limited container for use by children. Manufacturers of dental products should determine whether the levels of fluoride can be reduced while preserving clinical effectiveness.
- Communities with high natural fluoride levels in the public drinking water supply should comply with EPA regulations as mandated by the Safe Drinking Water Act. The current primary and secondary maximum contaminant levels for fluoride are 4ppm and 2ppm, respectively.
- The PHS is to develop an action plan to implement research and policy recommendations.

Research Recommendations

The following research recommendations are purposely broader than the policy recommendations to invite participation by a variety of public and private agencies and organizations.

Research on the Benefits of Fluorides

- Conduct surveys to evaluate the prevalence of dental caries over time and accurately assess exposure to fluoride.
- Undertake studies to elucidate further the role of fluoride in preventing coronal and root decay of adult teeth. Undertake studies to identify effective means of providing fluoride to individuals at high risk of dental caries.
- Continue long-term studies of caries scores in cities after defluoridation or the discontinuation of fluoridation as a supplement to past information that covers only 2-5 years of follow-up period.
- Document the marginal risks, costs, and benefits of providing multiple fluoride regimens in the prevention of dental caries.

- Determine the relationship among socioeconomic status, water-fluoridation status, and the use of fluoride products.
- In scoring dental caries, count individual surfaces rather than just the number of teeth because such scoring provides more information and greater sensitivity. Express reductions in caries scores as the number of tooth surfaces saved from caries, in addition to the percentage of reduction.

Research on the Risks of Fluoride

- Continue studies to elucidate the mechanisms of fluoride action on bone and teeth at the molecular and physical chemical level.
- Develop a method of quantitatively identifying dental fluorosis that is sensitive, specific, reliable, and acceptable to the public.
- Continue to study dental fluorosis to determine the etiology and trends in the prevalence of dental fluorosis.
- Conduct analytical epidemiologic studies of osteosarcoma to determine the risk factors associated with its development. Fluoride exposure and bone levels of fluoride should be included in the study design.
- Evaluate the scientific merit of conducting further animal carcinogenicity studies that use a wide range of chronic doses of fluoride. Industries sponsoring studies of fluoride should be encouraged to make their data publicly available to aid in this evaluation.
- Conduct analytic epidemiologic studies to determine the relationship, if any, among fluoride intake, fluoride bone levels, diet, body levels of nutrients such as calcium, and bone fractures.
- Conduct studies on the reproductive toxicity of fluoride using various dose levels, including the minimally toxic maternal dose.
- Conduct further studies to investigate whether fluoride is genotoxic.

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