ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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ARD-EHP-14 2008

Fluoride: Health Information Summary

Fluoride is widely found in water supplies, but usually below a concentration that would cause undesirable effects. The fluoride content of groundwater generally averages around 0.4 parts per million (ppm) nation-wide. The concentration of fluoride in natural waters depends primarily on the solubility of the fluoride contained in the rocks with which the water is in contact. Estimates made in the early 1990s indicated that about 1.6 million people have fluoride in their drinking water that exceeds the drinking water guideline (a Secondary Maximum Contaminant Level or SMCL) established to keep the occurrence and severity of dental fluorosis very low.

Fluoride is present to some extent in nearly all foods. However, some foods may make significant contributions to overall fluoride intake. These include some seafood, especially those that are often consumed with the bones such as sardines, products made from bone such as gelatin, and non-herbal teas. Commercial foods processed with fluoridated water or beverages made from fluoridated water may be additional hidden sources of fluoride. Most toothpaste sold today contains fluoride at 900 to 1,100 ppm.

Industrial exposure to fluoride in dusts and gases may occur most notably in processes such as grinding of fluoride-containing minerals, smelting, kiln firing of brick and other clay products, combustion of coal and in the aluminum and steel industries. However, the contribution of fluoride air pollution to most people's fluoride exposure is considered to be negligible.

Health Effects

Absorption

Fluoride can be absorbed from the gastrointestinal tract after ingestion, following inhalation, and through the skin. Soluble forms of fluoride, such as those added to fluoridate water, have been found to be absorbed at an efficiency of 90 percent or greater. Of the ingested fluoride that remains in the body, 99 percent is incorporated into the bones and teeth.

Inhalation and skin absorption can be significant for some occupational exposure situations, but are not important exposure routes for fluoride in drinking water.

Beneficial Health Effects

Fluoride is an essential nutrient for the proper development of teeth and bones. Fluoride prevents tooth decay by inhibiting the production of acid by decay-causing bacteria and enhancing the

remineralization of enamel that has been attacked. Fluoride also becomes incorporated into teeth, making them more decay resistant.

For approximately 60 years, fluoride has been added to drinking water in small amounts for prevention of dental caries (cavities). The usual dosage of added fluoride is in the range of 0.7 to 1.2 milligrams per liter (mg/liter), depending on climate. Since populations in warmer climates are expected to consume greater amounts of water, fluoride levels at the lower end of the range are sufficient for water supplies serving warmer areas. Fluoride in the 0.7 to 1.2 mg/l range provides optimal cavity prevention while keeping the occurrence of dental fluorosis at about 10 percent of the population, with the degree of fluorosis mostly in the "very mild" category. Dental fluorosis results in mottled white to brown tooth discolorations. As the fluoride level in water increases, so does the occurrence of dental fluorosis and the percentage of it that would be classified as "moderate" or "severe." In 2006, a scientific review committee report from the National Academy of Sciences (NAS) judged "severe" fluorosis to be an adverse health effect because it weakens tooth structure, making teeth more prone to cavities and fractures. The NAS Report concluded that information was not available to make a decision whether the adverse cosmetic appearance of light brown staining on teeth characterizing "moderate" dental fluorosis could have negative psychological or social effects on an individual such that it could also be considered as an adverse health effect.

Short-Term (Acute) Effects

Acute toxicity from fluoride is quite rare and has occurred principally as a result of exposure to excess fluoride in accidental poisonings. The symptoms of acute toxicity include severe nausea, vomiting, excess saliva production, abdominal pain, and diarrhea. Severe cases of exposure can result in convulsions, irregular heart beat, and coma. A few deaths have been reported when young children were found to have swallowed greater than 100 fluoride pills.

Young children are potentially at risk for acute effects because of the often attractive taste of fluoridated toothpaste. They should always be supervised when brushing and, as is appropriate for their age, made aware of the danger in swallowing excessive amounts.

Long-Term (Chronic) Effects

The major manifestation resulting from chronic ingestion of excessive amounts of fluoride is dental fluorosis. Only children up to approximately eight years old can be affected, because the condition occurs during tooth formation and before teeth first appear through the gums. In mild cases, mottling consists of small opaque paper-white areas scattered irregularly over the tooth surface. In severe mottling, discrete deep brown to black stained pits give the tooth a corroded appearance.

In the past, the U.S. Environmental Protection Agency (EPA) has considered dental fluorosis at any level of severity to be a cosmetic problem, rather than adversely effecting health. The EPA has found that exposure to fluoride at 1 to 2 ppm may contribute to "mild" to "moderate" dental fluorosis in a small percentage of persons. The frequency and severity of fluorosis increases as these levels are exceeded.

Families with young children who have greater than 2.0 mg/L (2.0 ppm) fluoride content in their water supply are advised to dilute the water consumed by children and infants and used in preparation of formula and food down to approximately 1.0 ppm with water containing little or no fluoride. Dilution to this concentration eliminates the possibility of "severe" dental fluorosis while maintaining the protective effect for developing teeth.

Some human and animal studies have provided evidence that high levels of fluoride may increase the risk of hip fractures in the population. After reviewing those studies, the majority of the NAS committee concluded that lifetime exposure to fluoride concentrations of 4 ppm and higher is likely to increase fracture rates compared to low exposures at around 1 ppm. Skeletal fluorosis results from chronic exposure to fluoride at levels greater than 4 ppm in drinking water. In its mildest form, it is characterized by a slight increase in bone density. In its most severe form, skeletal fluorosis is characterized by irregular bone deposits that may cause crippling arthritis when occurring in joints. Skeletal fluorosis is extremely rare in the US, but it is a public health problem in some countries.

Reproductive/Developmental Effects

The results of animal studies indicate that reproductive or developmental effects occur at high concentrations that humans would seldom encounter. Fluoride does transfer through the placenta to the fetus. Only a small amount of fluoride passes into breast milk. A few human studies have found an association between high fluoride levels and decreasing IQ scores. However, these studies did not control for other important factors influencing IQ such as nutrition and exposure to other chemicals. Some studies have suggested that there is a link between high fluoride exposure in drinking water and increases in Down Syndrome, but the studies have limitations, which reduce their usefulness for prediction.

Carcinogenic Effects (ability to cause cancer)

Population based human studies, for the most part, have been unable to detect any increases in cancer rates in areas that had fluoride added to their drinking water supplies when compared with areas with no added fluoride. A few investigations have detected positive associations between fluoride exposure in drinking water and a rare type of bone cancer called osteosarcoma. The association was found in young males. However, the osteosarcomas did not appear to be related to either the introduction of fluoride or the duration of fluoridation. Consequently, it was concluded that the incidence of this bone cancer was not due to fluoride exposure. Osteosarcoma in youths is the focus of fluoride cancer studies because most fluoride is deposited in bone, high doses have been found to stimulate cell division in osteoblasts, where new bone cells are formed, and, in humans, bone growth occurs in childhood and adolescence. As with other rare diseases, it is difficult for a study to be able to detect small increases of a disease in a population if it is occurring.

Animal studies have also been conducted investigating the potential for fluoride to cause cancer. The older studies do not indicate an association between fluoride and cancer, although these studies were somewhat limited. A study conducted by the National Toxicology Program (NTP) examining the effects of lifetime fluoride ingestion found a slight increase in bone cancer in male rats, although there was no evidence of increased cancer in female rats or mice of both sexes. The NTP concluded that there was “equivocal evidence” of carcinogenicity from this study indicating that an association between fluoride exposure and bone cancer was positive, but weak.

Another animal study found no evidence that fluoride exposure is associated with cancer, although mice were found to have increases in noncancerous bone tumors. In the most recent review of fluoride toxicology, the NAS Committee concluded that the conflicting evidence of some weakly positive associations between fluoride exposure and bone cancer and the negative evidence for an association requires additional studies to clarify this issue.

Health Standards and Criteria

The EPA has established a Maximum Contaminant Level Goal (MCLG) for fluoride in public drinking water systems. MCLGs are nonenforceable health standards for drinking water. MCLGs are set at a level at which no adverse health effects would be expected to result from the consumption of two liters (0.53 gallons) of contaminated water per day by a 70 kg (154 lb) adult. The MCLG for fluoride is 4 ppm.

The EPA has also established a Maximum Contaminant Level (MCL) for fluoride in public drinking water systems. MCLs are enforceable drinking water standards determined by balancing the adverse health effects of a particular chemical against the feasibility and cost of treating contaminated water. The MCL for fluoride is also 4 ppm.

To protect children against dental fluorosis, the SMCL of 2 ppm was established. Secondary MCLs are only guidelines for protection of the public welfare and are not enforceable.

The major conclusion of the NAS Report is that the MCLG of 4 ppm should be lowered because it does not protect against a percentage of the population experiencing "severe" dental fluorosis and increases in the rate of hip fracture.

Suggested Reading and References

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DSG revision 4/06