Fluoridation Facts

American Dental Association
www.ada.org

Celebrating 60 Years of Water Fluoridation

DEDICATION

This 2005 edition of Fluoridation Facts is dedicated to
Dr. Herschel Horowitz, talented researcher, renowned dental epidemiologist
and tireless advocate of community water fluoridation.

ABOUT FLUORIDATION FACTS

Fluoridation Facts contains answers to frequently asked questions regarding community water fluoridation. A number of these questions are based on myths and misconceptions advanced by a small faction opposed to water fluoridation. The answers to the questions that appear in *Fluoridation Facts* are based on generally accepted, peer-reviewed, scientific evidence. They are offered to assist policy makers and the general public in making informed decisions. The answers are supported by thousands of credible scientific articles, including the more than 350 references within the document. It is hoped that decision-makers will make sound choices based on this body of generally accepted, peer-reviewed science.

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Principal staff contributions to this edition of Fluoridation Facts were made by: Ms. Jane S. McGinley, RDH, MBA, Manager and Ms. Nicole M. Stoufflet, RDH, MHS, Coordinator, Fluoridation and Preventive Health Activities, Council on Access, Prevention and Interprofessional Relations.

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DISCLAIMER

This publication is designed to answer frequently asked questions about community water fluoridation, based on a summary of relevant published articles. It is not intended to be a comprehensive review of the extensive literature on fluoridation and fluorides. Readers must also rely on their own review of the literature, including the sources cited herein and any subsequent published, for a complete understanding of these issues.

American Dental Association
www.ada.org

ADA Statement Commemorating the 60th Anniversary of Community Water Fluoridation

Sixty years ago, Grand Rapids, Michigan became the world's first city to adjust the level of fluoride in its water supply. Since that time, fluoridation has dramatically improved the oral health of tens of millions of Americans. Community water fluoridation is the single most effective public health measure to prevent tooth decay. Additionally, the Centers for Disease Control and Prevention proclaimed community water fluoridation as one of 10 great public health achievements of the 20th century.

Fluoridation of community water supplies is simply the precise adjustment of the existing naturally occurring fluoride levels in drinking water to an optimal fluoride level recommended by the U.S. Public Health Service (0.7 – 1.2 parts per million) for the prevention of dental decay. Based on data from 2002, approximately 170 million people (or over two-thirds of the population) in the United States are served by public water systems that are fluoridated.

Studies conducted throughout the past 60 years have consistently indicated that fluoridation of community water supplies is safe and effective in preventing dental decay in both children and adults. It is the most efficient way to prevent one of the most common childhood diseases – tooth decay (5 times as common as asthma and 7 times as common as hay fever in 5- to17-year-olds).

Early studies, such as those conducted in Grand Rapids, showed that water fluoridation reduced the amount of cavities children get in their baby teeth by as much as 60% and reduced tooth decay in permanent adult teeth nearly 35%. Today, studies prove water fluoridation continues to be effective in reducing tooth decay by 20-40%, even in an era with widespread availability of fluoride from other sources, such as fluoride toothpaste.

The average cost for a community to fluoridate its water is estimated to range from approximately $0.50 a year per person in large communities to approximately $3.00 a year per person in small communities. For most cities, every $1 invested in water fluoridation saves $38 in dental treatment costs.

The American Dental Association continues to endorse fluoridation of community water supplies as safe and effective for preventing tooth decay. This support has been the Association's position since policy was first adopted in 1950. The ADA's policies regarding community water fluoridation are based on the overwhelming weight of peer-reviewed, credible scientific evidence. The ADA, along with state and local dental societies, continues to work with federal, state, local agencies and community coalitions to increase the number of communities benefiting from water fluoridation.

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EXECUTIVE SUMMARY

- Fluoridation of community water supplies is the single most effective public health measure to prevent dental decay.
- Throughout more than 60 years of research and practical experience, the overwhelming weight of credible scientific evidence has consistently indicated that fluoridation of community water supplies is safe.
- The Centers for Disease Control and Prevention has proclaimed community water fluoridation (along with vaccinations and infectious disease control) as one of ten great public health achievements of the 20th century.
- More than 100 national and international health, service and professional organizations recognize the public health benefits of community water fluoridation for preventing dental decay.
- Studies prove water fluoridation continues to be effective in reducing dental decay by 20-40%, even in an era with widespread availability of fluoride from other sources, such as fluoride toothpaste.
- Community water fluoridation benefits everyone, especially those without access to regular dental care. It is the most efficient way to prevent one of the most common childhood diseases – dental decay (5 times as common as asthma and 7 times as common as hay fever in 5-to-17-year-olds). Without fluoridation, there would be many more than the estimated 51 million school hours lost per year in this country because of dental-related illness.
- Community water fluoridation is the adjustment of fluoride that occurs naturally in water to optimal levels to protect oral health.
- For most cities, every $1 invested in water fluoridation saves $38 in dental treatment costs.
- Water that has been fortified with fluoride is similar to fortifying salt with iodine, milk with vitamin D and orange juice with vitamin C.
- Simply by drinking water, people can benefit from fluoridation's cavity protection whether they are at home, work or school.
- The average cost for a community to fluoridate its water is estimated to range from approximately $0.50 a year per person in large communities to approximately $3.00 a year per person in small communities.
- More than two-thirds of the population in the United States are served by public water systems that are optimally fluoridated.
- In the past five years (2000 through 2004), more than 125 U.S. communities in 36 states have voted to adopt fluoridation.
- Fluoridation has been thoroughly tested in the United States' court system, and found to be a proper means of furthering public health and welfare. No court of last resort has ever determined fluoridation to be unlawful.
- Be aware of misinformation on the Internet and other junk science related to water fluoridation.
- One of the most widely respected sources for information regarding fluoridation and fluorides is the American Dental Association. The ADA maintains Fluoride and Fluoridation Web pages at http://www.ada.org/goto/fluoride.

Fluoridation Facts

INTRODUCTION

Since 1956, the American Dental Association (ADA) has published *Fluoridation Facts*. Revised periodically, *Fluoridation Facts* answers frequently asked questions about community water fluoridation. In this 2005 edition issued as part of the 60th Anniversary celebration of community water fluoridation, the ADA Council on Access, Prevention and Interprofessional Relations provides updated information for individuals and groups interested in the facts about fluoridation. The United States now has over 60 years of practical experience with community water fluoridation. Its remarkable longevity is testimony to fluoridation's significance as a public health measure. In recognition of the impact that water fluoridation has had on the oral and general health of the public, in 1999, the Centers for Disease Control and Prevention named fluoridation of drinking water as one of ten great public health achievements of the 20th century.[1,2]

Support for Water Fluoridation

Since 1950, the American Dental Association (ADA), along with the United States Public Health Service (USPHS), has continuously and unreservedly endorsed the optimal fluoridation of community water supplies as a safe and effective public health measure for the prevention of dental decay. The ADA's policy is based on its continuing evaluation of the scientific research on the safety and effectiveness of fluoridation. Since 1950, when the ADA first adopted policy recommending community water fluoridation, the ADA has continued to reaffirm its position of support for water fluoridation and has strongly urged that its benefits be extended to communities served by public water systems.[3] The 2005 "ADA Statement Commemorating the 60th Anniversary of Community Water Fluoridation" reinforced that position.[4] Fluoridation is the most effective public health measure to prevent dental decay for children and adults, reduce oral health disparities and improve oral health over a lifetime.[5]

The American Dental Association, the U.S. Public Health Service, the American Medical Association and the World Health Organization all support community water fluoridation. Other national and international health, service and professional organizations that recognize the public health benefits of community water fluoridation for preventing dental decay are listed on the inside back cover of this publication.

Scientific Information on Fluoridation

The ADA's policies regarding community water fluoridation are based on generally accepted scientific knowledge. This body of knowledge is based on the efforts of nationally recognized scientists who have conducted research using the scientific method, have drawn appropriate balanced conclusions based on their research findings and have published their results in refereed (peer-reviewed) professional journals that are widely held or circulated. Studies showing the safety and effectiveness of water fluoridation have been confirmed by independent scientific studies conducted by a number of nationally and internationally recognized scientific investigators. While opponents of fluoridation have questioned its safety and effectiveness, none of their charges has ever been substantiated by generally accepted science.

With the advent of the Information Age, a new type of "pseudo-scientific literature" has developed. The public often sees scientific and technical information quoted in the press, printed in a letter to the editor or distributed via an Internet Web page. Often the public accepts such information as true simply because it is in print. Yet the information is not always based on research conducted according to the scientific method, and the conclusions drawn from research are not always scientifically justifiable. In the case of water fluoridation, an abundance of misinformation has been circulated. Therefore, scientific information from all print and electronic sources must be critically reviewed before conclusions can be drawn. (See Figure 1.) Pseudo-scientific literature may peak a reader's interest but when read as science, it can be misleading. The scientific validity and relevance of claims made by opponents of fluoridation might be best viewed when measured against criteria set forth by the U.S. Supreme Court.

Additional information on this topic may be found in Question 52.

History of Water Fluoridation

Research into the beneficial effects of fluoride began in the early 1900s. Frederick McKay, a young dentist, opened a dental practice in Colorado Springs, Colorado, and was surprised to discover that many local residents exhibited brown stains on their permanent teeth. Dr. McKay could find no documentation of the condition in the dental literature and eventually convinced Dr. G.V. Black, dean of the Northwestern University Dental School in Chicago, to join him in studying the condition. Through their research, Drs. Black and McKay determined that mottled enamel, as Dr. Black termed the condition, resulted from developmental imperfections in teeth. (Mottled enamel is a historical term. Today, this condition is called dental or enamel fluorosis.) Drs. Black and McKay wrote detailed descriptions of mottled enamel.[6,7]

In the 1920s, Dr. McKay, along with others, suspected that something either in or missing from the drinking

Figure 1. Key Elements In Reviewing Research

It is important to review information about fluoridation with a critical eye. Listed below are key elements to consider when reviewing information about fluoridation research.

1. **Credentials**: The author's background and credentials should reflect expertise in the area of research undertaken.

2. **Date**: The year of the publication should be apparent. The information should be relatively current, although well-designed studies can stand the test of time and scientific scrutiny. A review of existing literature can provide insight into whether the results of older studies have been superseded by subsequent studies.

3. **Accuracy**: If the information is a review of other studies, it should be accurate and representative of the original research. Information quoted directly from other sources should be quoted in its entirety.

4. **Statistical Methods**: The methods used to analyze the data should be generally accepted and appropriate.

5. **Comparability**: The research should be applicable to community water fluoridation and use an appropriate type and amount of fluoride. Many research projects investigate the use of fluoride at much higher levels than recommended for community water fluoridation. For example, the results of a study using a concentration of 125 parts per million (ppm) fluoride are not comparable to research findings regarding water fluoridated at 0.7 to 1.2 ppm.

6. **Type of Research**: How the research is conducted is relevant. Research conducted *in vitro* (outside the living body and in a laboratory environment) may not have the same results as research conducted *in vivo* (in a living human or other animal).

7. **Research Model**: A good study will try to replicate real life situations as close as possible. For example, results from animal studies using high doses of fluoride that are injected rather than provided in drinking water should be cautiously interpreted. Such studies are highly questionable as a predictor of the effects of human exposure to low concentrations of fluoride, such as those used to fluoridate water.

8. **Peer Review**: Publications presenting scientific information should be peer reviewed to help ensure that scientifically sound articles are published. Peer review involves evaluation and rating of the scientific and technical merit of an article by other qualified scientists.

9. **Weight of Evidence**: Conclusions from one particular study or one particular researcher should be weighed against the bulk of established, generally accepted, peer-reviewed science. No single study by itself is conclusive. If other researchers have not been able to replicate the results of a particular study or the work of one researcher, the results of that study or body of research should be viewed with some skepticism.

10. **Easily Accessible**: Reputable studies on fluoridation are typically published in peer-reviewed journals and other vehicles that are easily obtainable through a medical/dental library or through *PubMed*, a service of the National Library of Medicine which can be accessed via the Internet at http://www.nlm.nih.gov/.

water was causing the mottled enamel. Dr. McKay wrote to the Surgeon General in 1926 indicating that he had identified a number of regions in Colorado, New Mexico, Arizona, California, Idaho, South Dakota, Texas and Virginia where mottled enamel existed. Also in the late 20s, Dr. McKay made another significant discovery – these stained teeth were surprisingly resistant to decay.[7]

Following additional studies completed in the early 1930s in St. David, Arizona[8] and Bauxite, Arkansas,[9] it was determined that high levels of naturally occurring fluoride in the drinking water were causing the mottled enamel. In Arizona, researchers scrutinized 250 residents in 39 local families and were able to rule out hereditary factors and environmental factors, except for one - fluoride in the water which occurred naturally at levels of 3.8 to 7.15 ppm. In Bauxite, H. V. Churchill, chief chemist with the Aluminum Company of America (later changed to ALCOA), was using a new method of spectrographic analysis in his laboratory to look at the possibility that the water from an abandoned deep well in the area might have high levels of aluminum-containing bauxite that was causing mottled teeth. What he found was that the water contained a high level of naturally occurring fluoride (13.7 ppm). When Dr. McKay learned of this new form of analysis and Dr. Churchill's findings, he forwarded samples of water from areas where mottled enamel was commonplace to Dr. Churchill. All of the samples were found to have high levels of fluoride when compared to waters tested from areas with no mottled enamel.[7]

During the 1930s, Dr. H. Trendley Dean, a dental officer of the U.S. Public Health Service, and his associates conducted classic epidemiological studies on the geographic distribution and severity of fluorosis in the United States.[10] These early studies were aimed at evaluating how high the fluoride levels in water could be before visible, severe dental fluorosis occurred. By 1936, Dean and his staff had made the critical discovery that fluoride levels of up to 1.0 part per million (ppm) in the drinking water did not cause the more severe forms of dental fluorosis. Dean additionally noted a correlation between fluoride levels in the water and reduced incidence of dental decay.[11,12]

In 1939, Dr. Gerald J. Cox and his associates at the Mellon Institute evaluated the epidemiological evidence and conducted independent laboratory studies. While the issue was being discussed in the dental research community at the time, they were the first to publish a paper that proposed adding fluoride to drinking water to prevent dental decay.[13] In the 1940s, four classic, community-wide studies were carried out to evaluate the addition of sodium fluoride to fluoride-deficient water supplies. The first community water fluoridation program, under the direction of Dr. Dean, began in Grand Rapids, Michigan, in January 1945. The other three studies were conducted in Newburgh, New York (May 1945); Brantford, Ontario (June 1945) and Evanston, Illinois (February 1947.)[13-16] The astounding success of these studies firmly established fluoridation as a practical and safe public health measure to prevent dental decay that would quickly be embraced by other communities.

The history of water fluoridation is a classic example of a curious professional making exacting clinical observations which led to epidemiologic investigation and eventually to a safe and effective community-based public health intervention which even today remains the cornerstone of communities' efforts to prevent dental decay.

"The Centers for Disease Control and Prevention named fluoridation of drinking water one of ten great public health achievements of the 20th century noting that it is a major factor responsible for the decline in dental decay."

Water Fluoridation as a Public Health Measure

Throughout decades of research and more than sixty years of practical experience, fluoridation of public water supplies has been responsible for dramatically improving the public's oral health. In 1994, the U.S. Department of Health and Human Services issued a report which reviewed public health achievements. Along with other successful public health measures such as the virtual eradication of polio and reductions in childhood blood lead levels, fluoridation was lauded as one of the most economical preventive interventions in the nation.[17] A policy statement on water fluoridation reaffirmed in 1995 by the USPHS stated that water fluoridation is the most cost-effective, practical and safe means for reducing the occurrence of dental decay in a community.[18] In 1998, recognizing the ongoing need to improve health and well being, the USPHS revised national health objectives to be achieved by the year 2010. Included under oral health was an objective to significantly expand the fluoridation of public water supplies. Specifically, Objective 21-9 states that at least 75% of the U.S. population served by community water systems should be receiving the benefits of optimally fluoridated water by the year 2010.[19]

In 1999, the Centers for Disease Control and Prevention named fluoridation of drinking water one of ten

great public health achievements of the 20th century noting that it is a major factor responsible for the decline in dental decay.[1,2]

Former U.S. Surgeon General David Satcher issued the first ever Surgeon General report on oral health in May 2000. In *Oral Health in America: A Report of the Surgeon General,* Dr. Satcher stated that community water fluoridation continues to be the most cost-effective, practical and safe means for reducing and controlling the occurrence of dental decay in a community.[5,20] Additionally, Dr. Satcher noted that water fluoridation is a powerful strategy in efforts to eliminate health disparities among populations. Studies have shown that fluoridation may be the most significant step we can take toward reducing the disparities in dental decay.[5,20-24]

In the 2003 *National Call to Action to Promote Oral Health*, U.S. Surgeon General Richard Carmona called on policymakers, community leaders, private industry, health professionals, the media and the public to affirm that oral health is essential to general health and well being. Additionally, Surgeon General Carmona urged these groups to apply strategies to enhance the adoption and maintenance of proven community-based interventions such as community water fluoridation.[25]

Community water fluoridation is a most valuable public health measure because:

- Optimally fluoridated water is accessible to the entire community regardless of socioeconomic status, educational attainment or other social variables.[26]
- Individuals do not need to change their behavior to obtain the benefits of fluoridation.
- Frequent exposure to small amounts of fluoride over time makes fluoridation effective through the life span in helping to prevent dental decay.
- Community water fluoridation is more cost effective than other forms of fluoride treatments or applications.[27]

Water Fluoridation's Role in Reducing Dental Decay

Water fluoridation and the use of topical fluoride have played a significant role in improving oral health. Early studies showed that water fluoridation can reduce the amount of cavities children get in their baby teeth by as much as 60% and can reduce dental decay in permanent adult teeth by nearly 35%. Since that time, numerous studies have been published making fluoridation one of the most widely studied public health measures in history. Later studies prove water fluoridation continues to be effective in reducing dental decay by 20-40%, even in an era with widespread availability of fluoride from other sources, such as fluoride toothpaste.[28,29] Increasing numbers of adults are retaining their teeth throughout their lifetimes due in part to the benefits they receive from water fluoridation. Dental costs for these individuals are likely to have been reduced and many hours of needless pain and suffering due to untreated dental decay have been avoided.

"Water fluoridation continues to be effective in reducing dental decay by 20-40%, even in an era with widespread availability of fluoride from other sources, such as fluoride toothpaste."

It is important to note that dental decay is caused by dental plaque, a thin, sticky, colorless deposit of bacteria that constantly forms on teeth. When sugar and other carbohydrates are eaten, the bacteria in plaque produce acids that attack the tooth enamel. After repeated attacks, the enamel breaks down, and a cavity (hole) is formed. There are a number of factors that increase an individual's risk for dental decay:[27,30-33]

- Recent history of dental decay
- Elevated oral bacteria count
- Inadequate exposure to fluorides
- Exposed roots
- Frequent intake of sugar and sugary foods
- Poor or inadequate oral hygiene
- Decreased flow of saliva
- Deep pits and fissures in the chewing surfaces of teeth

Exposure to fluoride is not the only measure available to decrease the risk of decay. In formulating a decay prevention program, a number of intervention strategies may be recommended such as changes in diet and placement of dental sealants. However, fluoride is a key component in any recommended strategy.

Ongoing Need for Water Fluoridation

Because of the risk factors for dental decay noted previously, many individuals and communities still experience high levels of dental decay. Although water fluoridation demonstrates an impressive record of effectiveness and safety, only 67.3 % of the United States population on public water supplies receives fluoridated water containing protective levels of fluoride.[34] Unfortunately, some people continue to be confused about this effective public health measure. If the number of individuals drinking fluoridated water is to increase, the public must be accurately informed about its benefits.

BENEFITS

QUESTION 1.

What is fluoride?

Answer.
Fluoride is a naturally occurring compound that can help prevent dental decay.

Fact.

The fluoride ion comes from the element fluorine. Fluorine is an abundant element in the earth's crust in the form of the fluoride ion. As a gas, it never occurs in its free state in nature, but exists only in combination with other elements as a fluoride compound. Fluoride compounds are components of minerals in rocks and soil. Water passes over rock formations and dissolves the fluoride compounds that are present, releasing fluoride ions. The result is that small amounts of fluoride are present in all water sources. Generally, surface water sources such as lakes, rivers and streams have very low levels of fluoride. For example, Lake Michigan's fluoride level is 0.17 ppm.[35] As water moves through the earth, it contacts fluoride-containing minerals and carries away fluoride ions. The concentration of fluoride in groundwater varies according to such factors as the depth at which the water is found and the quantity of fluoride bearing minerals in the area.[36] In the United States, the natural level of fluoride in ground water varies from very low levels to over 4 ppm. The fluoride level of the oceans ranges from 1.2 to 1.4 ppm.[37,38] Fluoride is naturally present to some extent in all foods and beverages, but the concentrations vary widely.[39-41]

QUESTION 2.

How does fluoride help prevent dental decay?

Answer.
Fluoride protects teeth in two ways – systemically and topically.

Fact.

Systemic fluorides are those ingested into the body. During tooth formation, ingested fluorides become incorporated into tooth structures. Fluorides ingested regularly during the time when teeth are developing (preeruptively) are deposited throughout the entire tooth surface and provide longer-lasting protection than those applied topically.[42] Systemic fluorides can also give topical protection because ingested fluoride is present in saliva, which continually bathes the teeth providing a reservoir of fluoride that can be incorporated into the tooth surface to prevent decay. Fluoride also becomes incorporated into dental plaque and facilitates further remineralization.[43] Sources of systemic fluoride in the United States include fluoridated water, dietary fluoride supplements in the forms of tablets, drops or lozenges and fluoride present in food and beverages.

> *"Fluoride protects teeth in two ways – systemically and topically."*

While it was originally believed that fluoride's action was exclusively systemic or preeruptive, by the mid-1950s, there was growing evidence of both systemic and topical benefits of fluoride exposure.[44]

Additional information on this topic may be found in Question 11.

Topical fluorides strengthen teeth already present in the mouth (posteruptively). In this method of delivery, fluoride is incorporated into the surface of teeth making them more decay-resistant. Topically applied fluoride provides local protection on the tooth surface. Topical fluorides include toothpastes, mouthrinses and professionally applied fluoride foams, gels and varnishes. As mentioned previously, systemic fluorides also provide topical protection. Low levels of fluoride in saliva and plaque from sources such as optimally fluoridated water can prevent and reverse the process of dental decay.[45] In clarifying the effectiveness of water fluoridation, John D.B. Featherstone, PhD, Professor and Chair,

Department of Preventive and Restorative Dental Services, University of California San Francisco, noted: "… There is irrefutable evidence in numerous studies that fluoride in the drinking water works to reduce dental caries in populations. This is still the case."[46]

"John D.B. Featherstone, PhD, Professor and Chair, Department of Preventive and Restorative Dental Services, University of California San Francisco, noted: '…There is irrefutable evidence in numerous studies that fluoride in the drinking water works to reduce dental caries in populations.'"

The remineralization effect of fluoride is important. Fluoride ions in and at the enamel surface result in fortified enamel that is not only more resistant to decay (loss of minerals or demineralization), but enamel that can repair or remineralize early dental decay caused by acids from decay-causing bacteria.[42,47-51] Fluoride ions necessary for remineralization are provided by fluoridated water as well as various fluoride products such as toothpaste.

The maximum reduction in dental decay is achieved when fluoride is available preeruptively (systemically) for incorporation during all stages of tooth formation and posteruptively (topically) at the tooth surface. Water fluoridation provides both types of exposure.[44,52-54]

QUESTION 3.

What is water fluoridation?

Answer.

Water fluoridation is the adjustment of the natural fluoride concentration of fluoride-deficient water to the level recommended for optimal dental health.

Fact.

Based on extensive research, the United States Public Health Service (USPHS) established the optimum concentration for fluoride in the water in the United States in the range of 0.7 to 1.2 parts per million. This range effectively reduces dental decay while minimizing the occurrence of dental fluorosis. The optimum level is dependent on the annual average of the maximum daily air temperature in the geographic area.[55]

One milligram per liter (mg/L) of fluoride in water is identical to one part per million (ppm). At 1 ppm, one part of fluoride is diluted in a million parts of water. Large numbers such as a million can be very difficult to visualize. While not exact, the following comparisons can be of assistance in comprehending one part per million:

1 inch in 16 miles
1 minute in 2 years
1 cent in $10,000

For clarity, the following terms and definitions are used in this booklet:

Community water fluoridation is the adjustment of the natural fluoride concentration in water up to the level recommended for optimal dental health (a range of 0.7 to 1.2 ppm). Other terms used interchangeably in this booklet are water fluoridation, fluoridation and optimally fluoridated water. Optimal levels of fluoride may be present in the water naturally or by adjusted means.

Additional information on this topic may be found in Question 6.

Sub-optimally fluoridated water is water that naturally contains less than the optimal level (below 0.7 ppm) of fluoride. Other terms used interchangeably in this booklet are nonfluoridated water and fluoride-deficient water.

QUESTION 4.

How much fluoride is in your water?

Answer.

If your water comes from a public/community water supply, the options to learn the fluoride level of the water include contacting the local water supplier or the local/county/state health department, reviewing your Consumer Confidence Report (CCR) and using the Internet based "My Water's Fluoride." If your water source is a private well, it will need to be tested and the results obtained from a certified laboratory.

Fact.

The fluoride content of the local public or community water supply can be obtained by contacting the local water supplier or the local/county/state health department.

In 1999, the U.S. Environmental Protection Agency (EPA) began requiring water suppliers to put annual drinking water quality reports into the hands of its customers. Typically available around July 1st each year, these Water Quality Reports, or Consumer Confidence Reports (CCRs), may be mailed to your home, placed in the local newspaper or made available through the Internet.[56] To obtain a copy of the report, contact the local water supplier. The name of the water system (often not the name of the city) can be found on the water bill. If the name of the public water system is unknown, contact the local health department.

There are two sites on the Internet that supply information on water quality. The online source for water quality reports or CCRs is the EPA web site at http://www.epa.gov/safewater/dwinfo/index.html.[57]

Additionally, the Centers for Disease Control and Prevention's (CDC) fluoridation Web site, "My Water's Fluoride," is available at http://apps.nccd.cdc.gov/MWF/Index.asp.[58] For those states that have provided information to the CDC, the site lists fluoridation status by water system.

The EPA does not have the authority to regulate private drinking water wells. However, the EPA recommends that private well water be tested every year. While the EPA does not specifically recommend testing for the level of fluoride, health professionals will need this information prior to consideration of prescription of dietary fluoride supplements or to counsel patients about alternative water sources to reduce the risk of fluorosis if the fluoride levels are above 2 ppm.[59]

Additional information on this topic may be found in Questions 12, 24, 25 and 42.

Always use a state certified laboratory that conducts drinking water tests.[59] For a list of state certified labs, contact the local, county or state water/health department.

QUESTION 5.

What additives are used to fluoridate water supplies in the United States?

Answer.

Sodium fluoride, sodium fluorosilicate and fluorosilicic acid are the three additives approved for community water fluoridation in the United States. Sodium fluorosilicate and fluorosilicic acid are sometimes referred to as silicofluoride additives.

Fact.

The three basic additives used to fluoridate water in the United States are: 1) sodium fluoride which is a white, odorless material available either as a powder or crystals; 2) sodium fluorosilicate which is a white or yellow-white, odorless crystalline material and 3) fluorosilicic acid which is a white to straw-colored liquid.[36,60]

While fluoridation began in 1945 with the use of sodium fluoride, the use of silicofluorides began in 1946 and, by 1951, they were the most commonly used additives.[61] First used in the late 1940s, fluorosilicic acid is currently the most commonly used additive to fluoridate communities in the U.S.[36,61]

"To ensure the public's safety, standards have been established to ensure the safety of fluoride additives used in water treatment in the U.S."

To ensure the public's safety, standards have been established to ensure the safety of fluoride additives used in water treatment in the U.S. Specifically, additives used in water fluoridation meet standards of the American Water Works Association (AWWA) and NSF International (NSF).

Additional information on the topic of fluoride additives may be found in Fluoridation Practice Section.

QUESTION 6.

Is there a difference in the effectiveness between naturally occurring fluoridated water (at optimal fluoride levels) and water that has fluoride added to reach the optimal level?

Answer.

No. The dental benefits of optimally fluoridated water occur regardless of the fluoride's source.

Fact.

Fluoride is present in water as "ions" or electrically charged atoms.[36] These ions are the same whether acquired by water as it seeps through rocks and sand or added to the water supply under carefully controlled conditions. When fluoride is added under controlled conditions to fluoride-deficient water, the dental benefits are the same as those obtained from naturally fluoridated water. Fluoridation is merely an increase of the level of the naturally occurring fluoride present in all drinking water sources.

"Fluoridation is merely an increase of the level of the naturally occurring fluoride present in all drinking water sources."

Some individuals use the term "artificial fluoridation" to imply that the process of water fluoridation is unnatural and that it delivers a foreign substance into a water supply when, in fact, all water sources contain some fluoride. Community water fluoridation is a natural way to improve oral health.[62]

Additional information on this topic may be found in Question 45.

Prior to the initiation of "adjusted" water fluoridation, several classic epidemiological studies were conducted that compared naturally occurring fluoridated water to fluoride-deficient water. Strikingly low decay rates were found to be associated with the continuous use of water with fluoride content of 1 part per million.[12]

A fluoridation study conducted in the Ontario, Canada, communities of Brantford (optimally fluoridated by adjustment), Stratford (optimally fluoridated naturally) and Sarnia (fluoride-deficient) revealed much lower decay rates in both Brantford and Stratford as compared to nonfluoridated Sarnia. There was no observable difference in decay-reducing effect between the naturally occurring fluoride and adjusted fluoride concentration water supplies, proving that dental benefits were similar regardless of the source of fluoride.[16]

QUESTION 7.

Is water fluoridation effective in helping to prevent dental decay?

Answer.

Overwhelming evidence exists to prove the effectiveness of water fluoridation. Water fluoridation is a very effective method for preventing dental decay for children, adolescents and adults. Continued assessment, however, is important as the patterns and extent of dental decay change in populations.

Fact.

The effectiveness of water fluoridation has been documented in scientific literature for over 60 years. (See Figure 2.) Even before the first community fluoridation program began in 1945, epidemiologic data from the 1930s and 1940s revealed lower number of cavities in children consuming naturally occurring fluoridated water compared to children consuming fluoride-deficient water.[11,12] Since that time, thousands of studies have been done which continue to prove fluoride's effectiveness in decay reduction.

In Grand Rapids, Michigan, the first city in the world to fluoridate its water supply, a 15-year landmark study showed that children who consumed fluoridated water from birth had 50-63% less dental decay than children who had been examined during the original baseline survey completed in nonfluoridated Muskegon, Michigan.[63]

Ten years after fluoridation in Newburgh, New York, 6- to 9-year-olds had 58% less dental decay than their counterparts in nonfluoridated Kingston, New York, which was fluoride-deficient. After 15 years, 13- to 14-year-olds in Newburgh had 70% less decay than the children in Kingston.[64]

Figure 2. Effectiveness of Community Water Fluoridation

- **Centers for Disease Control and Prevention.** Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States. MMWR 2001;50 (No. RR-14). (Guidelines on the use of fluoride.)
- **Horowitz HS.** The effectiveness of community water fluoridation in the United States. J Public Health Dent 1996;56(5 Spec No):253-8. (A review of fifty years of water fluoridation.)
- **Murray JJ.** Efficacy of preventive agents for dental caries. Caries Res 1993;27(Suppl 1):2-8.(A review of studies conducted from 1976 through 1987.)
- **Newbrun E.** Effectiveness of water fluoridation. J Public Health Dent 1989;49(5):279-89. (The analysis of the results of 113 studies in 23 countries.)
- **Ripa LW.** A half-century of community water fluoridation in the United States: review and commentary. J Public Health Dent 1993;53(1):17-44. (The analysis of fifty years of water fluoridation.)

After 14 years of fluoridation in Evanston, Illinois, 14-year-olds had 57% fewer decayed, missing or filled teeth than the control group in Oak Park, Illinois, who drank water low in fluoride.[65]

In 1983, a study was undertaken in North Wales (Great Britain) to determine if the decay rate of fluoridated Anglesey continued to be lower than that of nonfluoridated Arfon, as had been indicated in a previous survey conducted in 1974. Decay rates of life-long residents in Anglesey, aged 5, 12 and 15, were compared with decay rates of identically aged residents in nonfluoridated Arfon. Study results demonstrated that a decline in decay had occurred in both communities since the previous survey in 1974. However, the mean decay rate of the children in fluoridated Anglesey was still 45% lower than that of those living in nonfluoridated Arfon.[66] These findings indicated a continuing need for fluoridation although decay levels had declined.[67]

In the United States, an epidemiological survey of nearly 40,000 schoolchildren was completed in 1987.[29] Nearly 50% of the children in the study aged 5 to 17 years were decay-free in their permanent teeth, which was a major change from a similar survey in 1980 in which approximately 37% were decay-free. This dramatic decline in decay rates was attributed primarily to the widespread use of fluoride in community water supplies, toothpastes, supplements and mouthrinses. Although decay rates had declined overall, data also revealed that the decay rate was 25% lower in children with continuous residence in fluoridated communities when the data was adjusted to control for fluoride exposure from supplements and topical treatments.

A controlled study conducted in 1990 demonstrated that average dental decay experience among schoolchildren who were lifelong residents of communities with low fluoride levels in drinking water was 61-100% higher as compared with dental decay experience among schoolchildren who were lifelong residents of a community with an optimal level of fluoride in the drinking water.[68] In addition, the findings of this study suggest that community water fluoridation still provides significant public health benefits and that dental sealants can play a significant role in preventing dental decay.

Using data from the dental surveys in 1991-2 and 1993-4, a British study predicted that on average, water fluoridation produces a 44% reduction in dental decay in 5-year-old children. The study further demonstrated that children in lower socioeconomic groups derive an even greater benefit from water fluoridation with an average 54% reduction in dental decay. Therefore, children with the greatest dental need benefit the most from water fluoridation.[69]

In 1993, the results of 113 studies in 23 countries were compiled and analyzed.[70] (Fifty-nine out of the 113 studies analyzed were conducted in the United States.) This review provided effectiveness data for 66 studies in primary teeth and for 86 studies in permanent teeth. Taken

together, the most frequently reported decay reductions observed were:

40-49% for primary teeth or baby teeth; and
50-59% for permanent teeth or adult teeth.

In a second review of studies conducted from 1976 through 1987,[28] when data for different age groups were separated, reductions in dental decay in fluoridated communities were:

30-60% in the primary dentition or baby teeth;
20-40% in the mixed dentition* (aged 8 to 12); (*A mixed dentition is composed of both baby teeth and adult teeth.)
15-35% in the permanent dentition or adult teeth (aged 14 to 17); and
15-35% in the permanent dentition (adults and seniors).

A comprehensive analysis of the 50-year history of community water fluoridation in the United States further demonstrated that the inverse relationship between higher fluoride concentration in drinking water and lower levels of dental decay discovered a half-century ago continued to be true.[71]

Baby bottle tooth decay is a severe type of early childhood decay that seriously affects babies and toddlers in some populations. Water fluoridation is highly effective in preventing decay in baby teeth, especially in children from low socioeconomic groups.[72] In a 1998 review of the effectiveness of methods currently used to prevent this type of decay, water fluoridation received the highest rating. For very young children, water fluoridation is the only means of prevention that does not require a dental visit or motivation of parents and caregivers.[73]

In 2001, the National Institutes of Health (NIH) held a consensus development conference, "Diagnosis and Management of Dental Caries Throughout Life." As part of the Consensus Statement issued at the conclusion of the conference, the panel noted that water fluoridation is widely accepted as both effective and of great importance in the primary prevention of tooth decay.[74]

"Children with the greatest dental need benefit the most from water fluoridation...The U.S. Task Force strongly recommended that community water fluoridation be included as part of a comprehensive population-based strategy to prevent or control tooth decay in communities."

A systematic review of published studies conducted in 2001 by a team of experts on behalf of the U.S. Task Force on Community Preventive Services found that fluoridation was effective in reducing tooth decay among populations. Based on strong evidence of effectiveness, the Task Force strongly recommended that community water fluoridation be included as part of a comprehensive population-based strategy to prevent or control tooth decay in communities.[75-78]

QUESTION 8.

With other forms of fluoride now available, is water fluoridation still an effective method for preventing dental decay?

Answer.

Although other forms of fluoride are available, persons in nonfluoridated communities continue to demonstrate higher dental decay rates than their counterparts in communities with water fluoridation.[68,70,72,79-83]

Fact.

In the 1940s, children in communities with optimally fluoridated drinking water had reductions in decay rates of approximately 60% as compared to those living in nonfluoridated communities. At that time, drinking water was the only source of fluoride other than fluoride that occurs naturally in foods.

Recent studies reveal that decay rates have declined in naturally or adjusted fluoridated areas and nonfluoridated areas as well. One factor is the high geographic mobility of our populations. In other words, it is becoming increasing difficult to study large numbers of people in one location who have a history of consuming only fluoridated or nonfluoridated water.

"Even in an era with widespread availability of fluoride from other sources, studies prove water fluoridation continues to be effective in reducing dental decay by 20-40%."

A second factor is the universal availability of fluoride from other sources including food, beverages, dental products (toothpaste, rinses, professionally applied foams, gels and varnish) and dietary supplements.[84] Foods and beverages processed in optimally fluoridated cities can contain higher levels of fluoride than those processed in nonfluoridated communities. These foods and beverages are consumed not only in the city where processed, but may be distributed to and consumed in nonfluoridated areas.[256] This "halo" or "diffusion" effect results in increased fluoride intake by people in nonfluoridated communities, providing them increased protection against dental decay.[52,71,86] As a result of the widespread availability of these various sources of fluoride, the difference between decay rates in fluoridated areas and nonfluoridated areas is somewhat less than several decades ago but it is still significant.[87] Failure to account for the diffusion effect may result in an underestimation of the total benefit of water fluoridation especially in areas where large quantities of fluoridated products are brought into nonfluoridated communities.[86]

Even in an era with widespread availability of fluoride from other sources, studies prove water fluoridation continues to be effective in reducing dental decay by 20-40%.[28,29]

8.
9.

QUESTION 9.

What happens if water fluoridation is discontinued?

Answer.

Over time, dental decay can be expected to increase if water fluoridation in a community is discontinued, even if topical products such as fluoride toothpaste and fluoride rinses are widely used.

Fact.

The following paragraphs provide a summary of key historical studies that have been conducted on the discontinuation of water fluoridation.

Antigo, Wisconsin began water fluoridation in June 1949, and ceased adding fluoride to its water in November 1960. After five and one-half years without optimal levels of fluoride, second grade children had over 200% more decay, fourth graders 70% more, and sixth graders 91% more than those of the same ages in 1960. Residents of Antigo re-instituted water fluoridation in October 1965 on the basis of the severe deterioration of their children's oral health.[88]

Because of a government decision in 1979, fluoridation in the northern Scotland town of Wick was discontinued after eight years. The water was returned to its sub-optimal, naturally occurring fluoride level of 0.02 ppm. Data collected to monitor the oral health of Wick children clearly demonstrated a negative health effect from the discontinuation of water fluoridation. Five years after the cessation of water fluoridation, decay in permanent (adult) teeth had increased 27% and decay in primary (baby) teeth increased 40%. This increase in decay occurred during a period when there had been a reported overall reduction in decay nationally and when fluoride toothpaste had been widely adopted.[89] These data suggest that decay levels in children can be expected to rise where water fluoridation is interrupted or terminated, even when topical fluoride products are widely used.

In a similar evaluation, the prevalence of decay in 10-year-old children in Stranraer, Scotland increased after the discontinuation of water fluoridation, resulting in a 115% increase in the mean cost of restorative dental treatment for decay and a 21% increase in the mean cost of all dental treatment. These data support the important role water fluoridation plays in the reduction of dental decay.[90]

A U.S. study of 6- and 7-year-old children who had resided in optimally fluoridated areas and then moved to the nonfluoridated community of Coldwater, Michigan, revealed an 11% increase in decayed, missing or filled tooth surfaces (DMFS) over a 3-year period from the time the children moved. These data reaffirm that relying only on topical forms of fluoride is not an effective or prudent public health practice.[28,91] Decay reductions are greatest where water fluoridation is available in addition to topical fluorides, such as fluoride toothpaste and fluoride rinses.

Finally, a study that reported the relationship between fluoridated water and decay prevalence focused on the city of Galesburg, Illinois, a community whose public water supply contained naturally occurring fluoride at 2.2 ppm. In 1959, Galesburg switched its community water source to the Mississippi River. This alternative water source provided the citizens of Galesburg a sub-optimal level of fluoride at approximately 0.1 ppm. During the time when the fluoride content was below optimal levels, data revealed a 10% decrease in the number of decay-free 14-year-olds (oldest group observed), and a 38% increase in dental decay. Two years later, in 1961, the water was fluoridated at the recommended level of 1.0 ppm.[92]

There have been several studies from outside the United States that have reported no increase in dental decay following the discontinuation of fluoridation. However, in all of the cases reported, the discontinuation of fluoridation coincided with the implementation of other measures to prevent dental decay.

For example, in La Salud, Cuba a study on dental decay in children indicated that the rate of dental decay did not increase after fluoridation was stopped in 1990. However, at the time fluoridation was discontinued a new topical fluoride program was initiated where all children received fluoride mouthrinses on a regular basis and children two to five received fluoride varnish once or twice a year.[93]

In Finland, a longitudinal study of Kuopio (fluoridated from 1959 to 1992) and Jyväskylä (low levels of natural fluoridation) showed little differences in decay rates between the two communities. This was attributed to a number of factors. The populations are extremely similar in terms of ethnic background and social structure. Virtually all children and adolescents used the government-sponsored, comprehensive, free dental care. The dental programs exposed the Finnish children to intense topical fluoride regimes and dental sealant programs. The result was that the effect of water fluoridation appeared minimal. Because of these unique set of factors, it was concluded these results could not be replicated in countries with less intensive preventive dental care programs.[94]

No significant decrease in dental decay was seen after fluoridation was discontinued in 1990 in Chemniz and Plauen which are located in what was formerly East Germany. The intervening factors in this case include improvements in attitudes toward oral health behaviors, broader availability and increased use of other preventive measures including fluoridated salt, fluoride toothpaste and dental sealants.[95]

A similar scenario is reported from the Netherlands. A study of 15-year-old children in Tiel (fluoridated 1953 to 1973) and Culemborg (nonfluoridated) was conducted comparing dental decay rates from a baseline in 1968 through 1988. The lower dental decay rate in Tiel after the cessation of fluoridation was attributed in part to the initiation of a dental health education program, free dietary fluoride supplements and a greater use of professionally applied topical fluorides.[96]

QUESTION 10.

Is dental decay still a serious problem?

Answer.

Yes. Dental decay or tooth decay is an infectious disease that continues to be a significant oral health problem.

Fact.

Dental decay is, by far, the most common and costly oral health problem in all age groups.[97] It is one of the principal causes of tooth loss from early childhood through middle age.[98,99] Decay continues to be problematic for middle-aged and older adults, particularly root decay because of receding gums. Older adults may experience similar or higher levels of dental decay than do children.[100] In addition to its effects in the mouth, dental decay can affect general well-being by interfering with an individual's ability to eat certain foods and by impacting an individual's emotional and social well-being by causing pain and discomfort. Dental decay, particularly in the front teeth, can detract from appearance, thus affecting self-esteem and employability.

"Decay continues to be problematic for middle-aged and older adults, particularly root decay because of receding gums."

Despite a decrease in the overall decay experience of U.S. schoolchildren over the past two decades, dental decay is still a significant oral health problem, especially in certain segments of the population. The 1986-1987 National Institute of Dental Research (NIDR) survey of approximately 40,000 U.S. school children found that 25% of students ages 5 to 17 accounted for 75% of the decay experienced in permanent teeth.[97] Despite progress in reducing dental decay, individuals in families living below the poverty level experience more dental decay than those who are economically better off.[20] Some of the risk factors that increase an individual's risk for decay are inadequate exposure to fluoride, irregular dental visits, deep pits and fissures in the chewing surfaces of teeth, inadequate flow of saliva, frequent sugar intake and very high oral bacteria counts.

Dental decay is one of the most common childhood diseases – five times as common as asthma and seven times as common as hay fever in 5- to 17-year-olds. Without fluoridation, there would be many more than the estimated 51 million school hours lost per year in this country because of dental-related illness.[101]

In addition to impacting emotional and social well-being, the consequences of dental disease are reflected in the cost of its treatment. According to the Centers for Medicare and Medicaid Services, the nation's total bill (including private and public spending) for dental services in 2003 was estimated to be $74.3 billion. This figure does not include indirect expenses of oral health problems or the cost of services by other health care providers.[102] Again, the goal must be prevention rather than repair. Fluoridation is presently the most cost-effective method for the prevention of dental decay for residents of a community in the United States.[103,104]

QUESTION 11.

Do adults benefit from fluoridation?

Answer.

Fluoridation plays a protective role against dental decay throughout life, benefiting both children and adults. In fact, inadequate exposure to fluoride places children and adults in the high risk category for dental decay.

Fact.

While the early fluoridation trials were not designed to study the possible benefits fluoridation might have for adults, by the mid-1950s, there was growing evidence of both systemic and topical benefits of fluoride exposure. It soon became evident that fluoridation helped prevent decay in adults, too.[44] Fluoride has both a systemic and topical effect and is beneficial to adults in two ways. The first is through the remineralization process in enamel, in which early decay does not enlarge, and can even reverse, because of frequent exposure to small amounts of fluoride. Studies have clearly shown that the availability of topical fluoride in an adult's mouth during the initial formation of decay can not only stop the decay process, but also make the enamel surface more resistant to future acid attacks. Additionally, the presence of systemic fluoride in saliva provides a reservoir of fluoride ions that can be incorporated into the tooth surface to prevent decay.[63]

Additional information on this topic may be found in Question 2.

"People in the United States are living longer and retaining more of their natural teeth than ever before."

Another protective benefit for adults is the prevention of root decay.[100,105-107] Adults with gum recession are at risk for root decay because the root surface becomes exposed to decay-causing bacteria in the mouth. Studies have demonstrated that fluoride is incorporated into the structure of the root surface, making it more resistant to decay.[118-112] In Ontario, Canada, lifelong residents of the naturally fluoridated (1.6 ppm) community of Stratford had significantly lower root decay experience than those living in the matched, but nonfluoridated, community of Woodstock.[111]

People in the United States are living longer and retaining more of their natural teeth than ever before. Because older adults experience more problems with gum reces-

sion, the prevalence of root decay increases with age. A large number of exposed roots or a history of past root decay places an individual in the high risk category for decay.[30] Data from the 1988-1991 National Health and Nutrition Examination Survey (NHANES III) showed that 22.5% of all adults with natural teeth experienced root decay. This percentage increased markedly with age:

1) in the 18- to 24-year-old age group, only 6.9% experienced root decay;
2) in the 35- to 44-year-old age group, 20.8% experienced root decay;
3) in the 55- to 64-year-old age group, 38.2% showed evidence of root decay; and
4) in the over-75 age group, nearly 56% had root decay.[113]

In addition to gum recession, older adults tend to experience decreased salivary flow, or xerostomia, due to the use of medications or medical conditions.[114,115] Inadequate flow of saliva places an individual in the high risk category for decay.[30] This decrease in salivary flow can increase the likelihood of dental decay because saliva contains calcium, phosphates and fluorides – all necessary for early repair of dental decay.

There are data to indicate that individuals who have consumed fluoridated water continuously from birth receive the maximum protection against dental decay. However, teeth present in the mouth when exposure to water fluoridation begins also benefit from the topical effects of exposure to fluoride. In 1989, a small study in the state of Washington suggested adults exposed to fluoridated water *only during childhood* had similar decay rates as adults exposed to fluoridated water *only after age 14*. This study lends credence to the topical and systemic benefits of water fluoridation. The topical effects are reflected in the decay rates of adults exposed to water fluoridation only after age 14. The study also demonstrates that the preeruptive, systemic effects of fluoridation have lifetime benefits as reflected in the decay rates of adults exposed to fluoridation only during childhood. The same study also noted a 31% reduction of dental disease (based on the average number of decayed or filled tooth surfaces) in adults with a continuous lifetime exposure to fluoridated water as compared to adults with no exposure to water fluoridation.[110]

> *"Water fluoridation contributes much more to overall health than simply reducing dental decay: it prevents needless infection, pain, suffering and loss of teeth; improves the quality of life and saves vast sums of money in dental treatment costs."*

A Swedish study investigating decay activity among adults in optimal and low fluoride areas revealed that not only was decay experience significantly lower in the optimal fluoride area, but the difference could not be explained by differences in oral bacteria, buffer capacity of saliva or salivary flow. The fluoride concentration in the drinking water was solely responsible for decreased decay rates.[116]

Water fluoridation contributes much more to overall health than simply reducing dental decay: it prevents needless infection, pain, suffering and loss of teeth; improves the quality of life and saves vast sums of money in dental treatment costs.[26] Additionally, fluoridation conserves natural tooth structure by preventing the need for initial fillings and subsequent replacement fillings.[117,118]

Additional information on this topic may be found in Question 2.

QUESTION 12.

Are dietary fluoride supplements effective?

Answer.

For children who do not live in fluoridated communities, dietary fluoride supplements are an effective alternative to water fluoridation for the prevention of dental decay.[119-122]

Fact.

Dietary fluoride supplements are available only by prescription in the United States and are intended for use by children living in nonfluoridated areas to increase their fluoride exposure so that it is similar to that received by children who live in optimally fluoridated areas.[123,124] Dietary fluoride supplements are available in two forms: drops for infants aged six months or older, and chewable tablets for children and adolescents.[124] **Fluoride supplements should only be prescribed for children living in nonfluoridated areas**. The **correct** amount of a fluoride supplement is based on the child's age and the existing fluoride level in the drinking water.[125] Because fluoride is so widely available, it is recommended that dietary fluoride supplements be used only according to the recommended dosage schedule and after consideration of all sources of fluoride exposure.[30,126] For optimum benefits, use of supplements should begin at six months of age and be continued daily until the child is at least 16 years old.[125] The current dietary fluoride supplement schedule is shown in Table 1 on the next page.

The relatively higher cost and need for compliance over an extended period of time is a major procedural and economic disadvantage of community-based fluoride supplement programs, one that makes them impractical as an alternative to water fluoridation as a public health measure. In a controlled situation, as shown in a study involving children of health professionals, fluoride supplements achieve effectiveness comparable to that of water fluoridation. However, even with this highly educated and motivated group of parents, only half continued to give their children fluoride tablets for the necessary number of years.[127] Additional studies have verified that

Table 1. Dietary Fluoride Supplement Schedule 1994[125]

Approved by the American Dental Association, American Academy of Pediatrics, American Academy of Pediatric Dentistry

Age	Fluoride ion level in drinking water (ppm)*		
	<0.3 ppm	**0.3-0.6 ppm**	**>0.6 ppm**
Birth – 6 months	None	None	None
6 months – 3 years	0.25 mg/day**	None	None
3 – 6 years	0.50 mg/day	0.25 mg/day	None
6 – 16 years	1.0 mg/day	0.50 mg/day	None

* 1.0 part per million (ppm) = 1 milligram/liter (mg/L) ** 2.2 mg sodium fluoride contains 1 mg fluoride ion.

individual patterns of compliance vary greatly.[128,129,130] Independent reports from several countries, including the United States, have demonstrated that community-wide trials of fluoride supplements in which tablets were distributed for use at home were largely unsuccessful because of poor compliance.[131]

While total costs for the purchase of supplements and administration of a program are small (compared with the initial cost of the installation of water fluoridation equipment), the overall cost of supplements per child is much greater than the per capita cost of community fluoridation.[104] In addition, community water fluoridation provides decay prevention benefits for the entire population regardless of age, socioeconomic status, educational attainment or other social variables.[26] This is particularly important for families who do not have access to regular dental services.

Additional information on this topic may be found in Questions 4, 13, 24 and 25.

13.

14.

15.

QUESTION 13.

Does the ADA recommend fluoride for children under six years of age?

Answer.

Yes. The ADA recognizes that lack of exposure to fluoride places individuals of any age at risk for dental decay. Fluoride exposure may take many forms including water fluoridation and dietary fluoride supplements.

Fact.

For children who live in nonfluoridated communities, dietary fluoride supplements are an effective alternative to water fluoridation to help prevent dental decay. Dietary fluoride supplements are available only by prescription and are intended for use by children living in nonfluoridated areas to increase their fluoride exposure so that it is similar to that experienced by children who live in optimally fluoridated areas.[124]

The dietary fluoride supplement schedule is just that – a *supplement* schedule (Table 1). Recognizing that children will receive fluoride from other sources (food and beverages) even in nonfluoridated areas, the amounts in the table reflect the *additional* amount of fluoride intake necessary to achieve an optimal anti-cavity effect.

> *"The dietary fluoride supplement schedule is just that – a* supplement *schedule."*

The dietary fluoride supplement schedule should not be viewed as recommending the absolute upper limits of the amount of fluoride that should be ingested each day. In 1997, the Food and Nutrition Board of the Institute of Medicine developed the Dietary Reference Intakes, a comprehensive set of reference values for dietary nutrient values. The new values present nutrient requirements to optimize health and, for the first time, set maximum-level guidelines to reduce the risk of adverse effects from excessive consumption of a nutrient. In the case of fluoride, levels were established to reduce dental decay without causing moderate dental fluorosis.[123]

For example, the dietary fluoride supplement schedule recommends that a two-year-old child living in a non-fluoridated area (where the primary water source contains less than 0.3 ppm fluoride) should receive 0.25 mg of *supplemental* fluoride per day. This does not mean that this child should ingest exactly 0.25 mg of fluoride per day. On the contrary, a two-year-old child could receive important anti-cavity benefits by taking 0.25 mg of supplemental fluoride a day without causing any adverse effects on health. This child would most probably be receiving fluoride from other sources (foods and beverages) even in a non-fluoridated area and the recommendation of 0.25 mg of fluoride per day takes this into account. In the unlikely event the child did not receive any extra fluoride from food and beverages, the 0.25 mg per day could be inadequate fluoride supplementation to achieve an optimal anti-cavity effect.

The following statement is correct. "The dosage has been lowered two different times as evidenced of too much fluoride has appeared." Rather than being a prob-

lem, as those opposed to the use of fluoride might imply, this is evidence that the ADA is doing the right thing. The ADA continually reviews available scientific evidence, and revises its statements based on the most current scientific information. In 1994, a Dietary Fluoride Supplement Workshop cosponsored by the ADA, the American Academy of Pediatric Dentistry and the American Academy of Pediatrics was held in Chicago. Based on a review of scientific evidence, a consensus was reached on a new dosage schedule developed in recognition that numerous sources of topical and systemic fluoride are available today that were not available many years ago.[125] The revised dietary fluoride supplement schedule appears as Table 1.

QUESTION 14.

In areas where water fluoridation is not feasible because of engineering constraints, are alternatives to water fluoridation available?

Answer.

Yes. Some countries outside the United States that do not have piped water supplies capable of accommodating community water fluoridation have chosen to use salt fluoridation.

Fact.

Salt fluoridation is used extensively in a number of countries in Europe (examples: France, Hungary, Germany, Spain and Switzerland) and Central and South America (examples: Boliva, Colombia, Cuba, Dominican Republic, Ecuador, El Salvador, Honduras, Nicaragua, Venezuela, Costa Rica, Jamaica, Mexico, Peru and Uruguay.)[132,133] The Pan American Health Organization (PAHO), a regional division of the World Health Association (WHO), with responsibilities for health matters in North, South and Central America as well as the Caribbean has been active in developing strategies to implement decay prevention programs in the regions of the Americas using both water and salt fluoridation.[133,134]

Studies evaluating the effectiveness of salt fluoridation outside the U.S. have concluded that fluoride delivered via salt may produce decay reductions similar to that of optimally fluoridated water.[135] An analysis of published results of studies from some countries shows that, for 12-year-old children, the initial level of decay reduction due to salt fluoridation is between 35% and 80%.[136,137]

An advantage of salt fluoridation is that it does not require a centralized piped water system. This is of particular use in many developing countries that do not have such water systems. When both domestic salt and bulk salt (used by commercial bakeries, restaurants, institutions, and industrial food production) is fluoridated, the decay-reducing effect may be comparable to that of water fluoridation over an extended period of time.[136] On the other hand, when only domestic salt is fluoridated, the decay-reducing effect may be diminished.[135]

Salt fluoridation has several disadvantages that do not exist with water fluoridation. Challenges occur with implementation of salt fluoridation when there are multiple sources of drinking water in an area. The natural fluoride level of each source must be determined and, if the level is optimal or excessive, fluoridated salt should not be distributed in that area.[138] Finally, there is general agreement that a high consumption of sodium is a risk factor for hypertension (high blood pressure).[139,140] People who have hypertension or must restrict their salt intake may find salt fluoridation an unacceptable method of receiving fluoride.

Additional information on this topic may be found in Question 56.

Fluoridated milk has been suggested as another alternative to community water fluoridation in countries outside the U.S. WHO has supported milk fluoridation feasibility projects in the United Kingdom, People's Republic of China, Peru and Thailand.[141] Studies among small groups of children have demonstrated a decrease in dental decay levels resulting from consumption of fluoridated milk; however, these studies were not based on large-scale surveys. More research is needed before milk fluoridation can be recommended as an alternative to water or salt fluoridation.[142] The rationale for adding fluoride to milk is that this method "targets" fluoride directly to children, but the amount of milk consumed by children is quite variable, more so than water. Concerns have been raised about decreased widespread benefits due to the slower absorption of fluoride from milk than from water and the considerable number of persons, especially adults, who do not drink milk for various reasons.[143] The monitoring of fluoride content in milk is technically more difficult than for drinking water because there are many more dairies than communal water supplies. In addition, because fluoridated milk should not be sold in areas having natural or adjusted fluoridation, regulation would be difficult, and established marketing patterns would be disrupted.[42]

QUESTION 15.

Can the consistent use of bottled water result in individuals missing the benefits of optimally fluoridated water?

Answer.

Yes. The majority of bottled waters on the market do not contain optimal levels (0.7-1.2 ppm) of fluoride.[144-148]

Fact.

Individuals who drink bottled water as their primary source of water could be missing the decay preventive effects of optimally fluoridated water available from their community water supply.

The consumption of bottled water in the United States has been growing by at least one gallon per person each year - more than doubling in the last ten years. Consumption rates for the past five years are shown in Table 2.[14]

Table 2. U.S. Bottled Water Market[149]		
Per Capita Consumption 2000-2004		
	Gallons	Annual
Year	Per Capita	% Change
2000	17.2	---
2001	18.7	8.7%
2002	20.7	10.8%
2003	22.1	7.0%
2004	23.8	7.6%

In 2004, total U.S. sales of bottled water surpassed 6.8 billion gallons, an 8.6% advance over 2003 with wholesale dollar sales reaching a record of approximately $9.2 billion. This category includes sparkling and non-sparkling water, domestic and imported water, water in single-serve bottles and larger packages as well as vended and direct delivered waters. U.S. residents now drink more bottled water annually (23.8 gallons per person in 2004) than any other beverage with the exception of carbonated soft drinks.[149,150] In 2004, consumption of carbonated soft drinks fell for the sixth straight year after several decades of uninhibited growth (53.7 gallons per person in 2004 compared to 54.8 gallons per person in 1999).[150]

16.

"Individuals who drink bottled water as their primary source of water could be missing the decay preventive effects of optimally fluoridated water available from their community water supply."

In 1994, a small study at two community health centers in Rhode Island showed that 55% of the total households responding used only bottled water for drinking while 59% of the households with children reported using only bottled water for drinking. The vast majority of these bottled waters had less than optimal levels of fluoride. While most of the patient population of the health centers was either on public assistance (60%) or uninsured (20%), families spent their limited resources to purchase bottled water. It was reported that 52% of children on public assistance and 35% of the uninsured children used bottled water.[151]

The fluoride content of bottled water can vary greatly. A 1989 study of pediatric dental patients and their use of bottled water found the fluoride content of bottled water from nine different sources varied from 0.04 ppm to 1.4 ppm.[152] In a 1991 study of 39 bottled water samples, 34 had fluoride levels below 0.3 ppm. Over the two years the study was conducted, six products showed a two- to four-fold drop in fluoride content.[153] A similar study of five national brands of bottled water conducted in 2000, showed that significant differences in fluoride concentration existed between the five brands and that three of the five brands tested demonstrated significant differences between the various batches tested of the same brand.[154]

In evaluating how bottled water consumption affects fluoride exposure, there are several factors to consider. First is the amount of bottled water consumed during the day. Second is whether bottled water is used for drinking, in meal preparation and for reconstituting soups, juices and other drinks. Third is whether another source of drinking water is accessed during the day such as an optimally fluoridated community water supply at day-care, school or work.

A final important issue is determining the fluoride content of the bottled water. While drinking water is regulated by the U.S. EPA,[155] bottled water is regulated by the U.S. Food and Drug Administration (FDA) which has established standards for its quality.[156]

Additional information on this topic may be found in Question 43.

Bottled water is defined as water that is intended for human consumption sealed in bottles or other containers with no added ingredients except that it may optionally contain safe and suitable antimicrobial agents. The FDA has established maximum allowable levels for physical, chemical, microbiological, and radiological contaminants in the bottled water quality standard regulations. The FDA has also approved standards for the optional addition of fluoride.[156] Effective in 1996, FDA regulations require fluoride content of bottled water to be listed on the label *only if fluoride is added during processing.*[157] If the fluoride level is not shown on the label of the bottled water, the company can be contacted, or the water can be tested to obtain this information.

For additional information on bottled water and fluoride exposure, view the ADA's Web page "Bottled Water, Home Water Treatment Systems and Fluoride Exposure" at http://www.ada.org/goto/bottledwater. (Figure 3)

Figure 3. Bottled Water/Home Water Treatment Systems

QUESTION 16.

Can home water treatment systems (e.g. water filters) affect optimally fluoridated water supplies?

Answer.

Yes. Some types of home water treatment systems can reduce the fluoride levels in water supplies potentially decreasing the decay-preventive effects of optimally fluoridated water.

Fact.

There are many kinds of home water treatment systems including water filters (for example: carafe filters, faucet filters, under the sink filters and whole house filters), reverse osmosis systems, distillation units and water softeners. There has not been a large body of research regarding the extent to which these treatment systems affect fluoridated water. Available research is often conflicting and unclear. However, it has been consistently documented that reverse osmosis systems and distillation units remove significant amounts of fluoride from the water supply.[41,158,159] On the other hand, repeated studies regarding water softeners confirm earlier research indicating the water softening process caused no significant change in fluoride levels.[160,161] With water filters, the fluoride concentration remaining in the water depends on the type and quality of the filter being used, the status of the filter and the filter's age. Some activated carbon filters containing activated alumina may remove significant amounts of the fluoride.[162] Each type of filter should be assessed individually.[159]

Individuals who drink water processed by home water treatment systems as their primary source of water could be losing the decay preventive effects of optimally fluoridated water available from their community water supply. Consumers using home water treatment systems should have their water tested at least annually to establish the fluoride level of the treated water. More frequent testing may be needed. Testing is available through local and state public health departments. Private laboratories may also offer testing for fluoride levels in water.

Information regarding the existing level of fluoride in a community's public water system can be obtained by asking a local dentist, contacting your local or state health department, or contacting the local water supplier.

Additional information on this topic may be found in Question 4.

For additional information on home water treatment systems and fluoride exposure, view the ADA's Web page "Bottled Water, Home Water Treatment Systems and Fluoride Exposure" at http://www.ada.org/goto/bottledwater. (Figure 3)

Notes

SAFETY

QUESTION 17.

Does fluoride in the water supply, at the levels recommended for the prevention of dental decay, adversely affect human health?

17.

18.

Answer.

The overwhelming weight of scientific evidence indicates that fluoridation of community water supplies is safe. (See Figure 4.)

Fact.

For generations, millions of people have lived in areas where fluoride is found naturally in drinking water in concentrations as high or higher than those recommended to prevent dental decay. Research conducted among these persons confirms the safety of fluoride in the water supply.[84,163-166] In fact, in August 1993, the National Research Council, a branch of the National Academy of Sciences, released a report prepared for the Environmental Protection Agency (EPA) that confirmed that the currently allowed fluoride levels in drinking water do not pose a risk for health problems such as cancer, kidney failure or bone disease.[167] Based on a review of available data on fluoride toxicity, the expert subcommittee that wrote the report concluded that the EPA's ceiling of 4 ppm for naturally occurring fluoride in drinking water was "appropriate as an interim standard."[167] Subsequently, the EPA announced that the ceiling of 4 ppm would protect against adverse health effects with an adequate margin of safety and published a notice of intent not to revise the fluoride drinking water standard in the *Federal Register*.[168]

As with other nutrients, fluoride is safe and effective when used and consumed properly. No charge against the benefits and safety of fluoridation has ever been substantiated by generally accepted scientific knowledge. After 60 years of research and practical experience, the preponderance of scientific evidence indicates that fluoridation of community water supplies is both safe and effective.[169]

> *"After 60 years of research and practical experience, the preponderance of scientific evidence indicates that fluoridation of community water supplies is both safe and effective."*

Many organizations in the U.S. and around the world involved with health issues have recognized the value of community water fluoridation. The American Dental Association (ADA) adopted its original resolution in support of fluoridation in 1950 and has repeatedly reaffirmed its position publicly and in its House of Delegates based on its continuing evaluation of the safety and effectiveness of fluoridation.[3] The 2005 "ADA Statement Commemorating the 60th Anniversary of Community Water Fluoridation" reinforced that position.[4] The American Medical Association's (AMA) House of Delegates first endorsed fluoridation in 1951. In 1986, and again in 1996, the AMA reaffirmed its support for fluoridation as an effective means of reducing dental decay.[170] The World Health Organization, which initially recommended the practice of water fluoridation in 1969,[171] reaffirmed its support for fluoridation in 1994 stating that: "Providing that a community has a piped water supply, water fluoridation is the most effective method of reaching the whole population, so that all social classes benefit without the need for active participation on the part of individuals."[138] Following a comprehensive 1991 review and evaluation of

Figure 4. Safety of Community Water Fluoridation

- **Institute of Medicine, Food and Nutrition Board.** Dietary reference intakes for calcium, phosphorus, magnesium, vitamin D and fluoride. Report of the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. Washington, DC: National Academy Press;1997.
- **National Research Council.** Health effects of ingested fluoride. Report of the Subcommittee on Health Effects of Ingested Fluoride. Washington, DC: National Academy Press;1993.
- **US Department of Health and Human Services, Public Health Service.** Review of fluoride: benefits and risks. Report of the Ad Hoc Subcommittee on Fluoride. Washington, DC; February 1991.
- **World Health Organization.** Fluorides and human health. Monograph series no 59. Geneva, Switzerland;1970.

the public health benefits and risks of fluoride, the U.S. Public Health Service reaffirmed its support for fluoridation and continues to recommend the use of fluoride to prevent dental decay.[84]

Recent statements by five leading health authorities on community water fluoridation can be found in the back of this publication.

National and international health, service and professional organizations that recognize the public health benefits of community water fluoridation for preventing dental decay are listed on the inside back cover of this publication.

QUESTION 18.

Are additional studies being conducted to determine the effects of fluorides in humans?

Answer.

Yes. Since its inception, fluoridation has undergone a nearly continuous process of reevaluation. As with other areas of science, additional studies on the effects of fluorides in humans can provide insight as to how to make more effective choices for the use of fluoride. The American Dental Association and the U.S. Public Health Service support this on-going research.

Fact.

For more than 60 years, thousands of reports have been published on all aspects of fluoridation.[84,167] The accumulated dental, medical and public health evidence concerning fluoridation has been reviewed and evaluated numerous times by academicians, committees of experts, special councils of government and most of the world's major national and international health organizations. The verdict of the scientific community is that water fluoridation, at recommended levels, safely provides major oral health benefits. The question of possible secondary health effects caused by fluorides consumed in optimal concentrations throughout life has been the object of thorough medical investigations which have failed to show any impairment of general health throughout life.[138,163-166]

"The verdict of the scientific community is that water fluoridation, at recommended levels, safely provides major oral health benefits."

In scientific research, there is no such thing as "final knowledge." New information is continuously emerging and being disseminated. Under the Safe Drinking Water Act (SDWA), the U. S. Environmental Protection Agency (EPA) must periodically review the existing National Primary Drinking Water Regulations (NPDWRs) "not less often than every 6 years." This review is a routine part of the EPA's operations as dictated by the SDWA.[172]

In April 2002, the EPA announced the results of its preliminary revise/not revise decisions for 68 chemical NPDWRs. Fluoride was one of the 68 chemicals reviewed. The EPA determined that it fell under the "Not Appropriate for Revision at this Time" category, but noted that it planned to ask the National Academy of Science (NAS) to update the risk assessment for fluoride. The NAS had previously completed a review of fluoride for EPA approximately 12 years ago which was published as "Health Effects of Ingested Fluoride" in 1993 by the National Research Council.

At the request of the NAS, the National Research Council's Committee on Toxicology created the Subcommittee on Fluoride in Drinking Water to review toxicologic, epidemiologic, and clinical data published since 1993 and exposure data on orally ingested fluoride from drinking water and other sources (e.g., food, toothpaste, mouthrinses). Based on this review the Subcommittee will evaluate the scientific and technical basis of the EPA's maximum contaminant level (MCL) of 4 milligram per liter (mg/L or ppm) and secondary maximum contaminant level (SMCL) of 2 mg/L for fluoride in drinking water. The Subcommittee will advise the EPA on the adequacy of its fluoride MCL and SMCL to protect children and others from adverse health effects and identify data gaps and make recommendations for future research relevant to setting the MCL and SMCL for fluoride. The Subcommittee began its work in November 2002 and is currently projected to complete the project in early 2006.[173]

The definition of a contaminant is a function of the National Primary Drinking Water Regulations. The EPA

considers a contaminant to be ANYTHING found in water that may be harmful to human health. The EPA has designated 90 microorganisms, minerals and chemicals as contaminants.[174,175]

While research continues, the weight of scientific evidence indicates water fluoridation is safe and effective in preventing dental decay in humans.[84]

Additional information on this topic may be found in Questions 7, 8, and 42.

QUESTION 19.

Does the total intake of fluoride from air, water and food pose significant health risks?

Answer.

The total intake of fluoride from air, water and food, in an optimally fluoridated community in the United States, does not pose significant health risks.

Fact.

Fluoride from the Air

The atmosphere normally contains negligible concentrations of airborne fluorides. Studies reporting the levels of fluoride in air in the United States suggest that ambient fluoride contributes little to a person's overall fluoride intake.[179,180]

19.

20.

Fluoride from Water

In the United States, the natural level of fluoride in ground water varies from very low levels to over 4 ppm. Public water systems in the U.S. are monitored by the Environmental Protection Agency (EPA), which requires that public water systems not exceed fluoride levels of 4 ppm.[168] The optimal concentration for fluoride in water in the United States has been established in the range of 0.7 to 1.2 ppm. This range will effectively reduce dental decay while minimizing the occurrence of mild dental fluorosis. The optimal fluoride level is dependent on the annual average of the maximum daily air temperature in the geographic area.[36]

Children living in a community with water fluoridation get a portion of their daily fluoride intake from fluoridated water and a portion from dietary sources which would include food and other beverages. When considering water fluoridation, an individual must consume one liter of water fluoridated at 1 part per million (1 ppm) to receive 1 milligram (1 mg) of fluoride.[42,178] Children under six years of age, on average, consume less than one-half liter of drinking water a day.[178] Therefore, children under six years of age would consume, on average, less than 0.5 mg of fluoride a day from drinking optimally fluoridated water (at 1 ppm).

A ten-year comparison study of long-time residents of Bartlett and Cameron, Texas, where the water supplies contained 8.0 and 0.4 parts per million of fluoride, respectively, included examinations of organs, bones and tissues. Other than a higher prevalence of dental fluorosis in the Bartlett residents, the study indicated that long term consumption of dietary fluoride (resident average length of fluoride exposure was 36.7 years), even at levels considerably higher than recommended for decay prevention, resulted in no clinically significant physiological or functional effects.[166]

Fluoride in Food

Foods and beverages commercially processed (cooked or reconstituted) in optimally fluoridated cities can contain higher levels of fluoride than those processed in nonfluoridated communities. These foods and beverages are consumed not only in the city where processed, but may be distributed to and consumed in nonfluoridated areas.[26] This "halo" or "diffusion" effect results in increased fluoride intake by people in nonfluoridated communities, providing them increased protection against dental decay.[71,85,86] As a result of the widespread availability of these various sources of fluoride, the difference between decay rates in fluoridated areas and nonfluoridated areas is somewhat less than several decades ago but still significant.[87] Failure to account for the diffusion effect may result in an underestimation of the total benefit of water fluoridation especially in areas where a large amount of fluoridated products are brought into nonfluoridated communities.[86]

Water and water-based beverages are the chief source of dietary fluoride intake. Conventional estimates are that approximately 75% of dietary fluoride comes from water and water-based beverages.[179]

The average daily dietary intake of fluoride (expressed on a body weight basis) by children residing in optimally fluoridated (1 ppm) communities is 0.05 mg/kg/day; in communities without optimally fluoridated water, average intakes for children are about 50% lower.[123] Dietary fluoride intake by adults in optimally fluoridated (1 ppm) areas averages 1.4 to 3.4 mg/day, and in nonfluoridated areas averages 0.3 to 1.0 mg/day.[123]

In looking at the fluoride content of food and beverages over time, it appears that fluoride intake from dietary sources has remained relatively constant. Except for samples prepared or cooked with fluoridated water, the fluoride content of most foods and beverages is not significantly different between fluoridated and nonfluoridated communities. When fluoridated water is used to prepare or cook the samples, the fluoride content of foods and beverages is higher as reflected in the intake amounts noted in the previous paragraph. This difference has remained relatively constant over time.[180,181]

The fluoride content of fresh solid foods in the United States generally ranges from 0.01 to 1.0 part per million.[102,179] It has long been known that fish, such as sardines, may contribute to higher dietary fluoride intake if the bones are ingested as fluoride has an affinity for calcified tissues. Additionally, brewed teas may also contain fluoride concentrations of 1 ppm to 6 ppm depending on the amount of dry tea used, the water flu-

oride concentration and the brewing time.[182] The fluoride value for unsweetened instant tea powder appears very high when reported as a dry powder because this product is extremely concentrated. However, when one teaspoon of the unsweetened tea powder is added to an eight ounce cup of tap water, the value for prepared instant tea is similar to the values reported for regular brewed tea.[179]

Unveiled in 2004, the National Fluoride Database is a comprehensive, nationally representative database of the fluoride concentration in foods and beverages consumed in the United States. The database for fluoride was designed for use by epidemiologists and health researchers to estimate fluoride intake and to assist in the investigation of the relationships between fluoride intake and human health. The database contains fluoride values for beverages, water, and some lower priority foods. [179]

QUESTION 20.

How much fluoride should an individual consume each day to reduce the occurrence of dental decay?

Answer.

The appropriate amount of daily fluoride intake varies with age and body weight. As with other nutrients, fluoride is safe and effective when used and consumed properly.

Fact.

In 1997, the Food and Nutrition Board of the Institute of Medicine developed a comprehensive set of reference values for dietary nutrient intakes.[123] These new reference values, the Dietary Reference Intakes (DRI), replace the Recommended Dietary Allowances (RDA) which had been set by the National Academy of Sciences since 1941. The new values present nutrient requirements to optimize health and, for the first time, set maximum-level guidelines to reduce the risk of adverse effects from excessive consumption of a nutrient. Along with calcium, phosphorous, magnesium and vitamin D, DRIs for fluoride were established because of its proven effect on dental decay.

As demonstrated in Table 3, fluoride intake in the United States has a large range of safety.

The first DRI reference value is the Adequate Intake (AI) which establishes a goal for intake to sustain a desired indicator of health without causing side effects. In the case of fluoride, the AI is the daily intake level required to reduce dental decay without causing moderate dental fluorosis. The AI for fluoride from all sources (fluoridated water, food, beverages, fluoride dental products and dietary fluoride supplements) is set at 0.05 mg/kg/day (milligram per kilogram of body weight per day).

Using the established AI of 0.05 mg/kg, the amount of fluoride for optimal health to be consumed each day has been calculated by gender and age group (expressed as average weight). See Table 3 in this Question.

The DRIs also established a second reference value for maximum-level guidelines called tolerable upper intake levels (UL). The UL is higher than the AI and is *not* the recommended level of intake. The UL is the estimated maximum intake level that should not produce unwanted effects on health. The UL for fluoride from all sources (fluoridated water, food, beverages, fluoride dental products and dietary fluoride supplements) is set at 0.10 mg/kg/day (milligram per kilogram of body weight per day) for infants, toddlers, and children through eight years of age. For older children and adults, who are no longer at risk for dental fluorosis, the UL for fluoride is set at 10 mg/day regardless of weight.

Table 3. Dietary Reference Intakes for Fluoride

Food and Nutrition Board of the Institute of Medicine 1997[123]

Age Group	Reference Weights kg (lbs)*	Adequate Intake (mg/day)	Tolerable Upper Intake (mg/day)
Infants 0-6 months	7 (16)	0.01	0.7
Infants 7-12 months	9 (20)	0.5	0.9
Children 1-3 years	13 (29)	0.7	1.3
Children 4-8 years	22 (48)	1.0	2.2
Children 9-13 years	40 (88)	2.0	10.0
Boys 14-18 years	64 (142)	3.0	10.0
Girls 14-18 years	57 (125)	3.0	10.0
Males 19 years and over	76 (166)	4.0	10.0
Females 19 years and over	61 (133)	3.0	10.0

* Value based on data collected during 1988-94 as part of the Third National Health and Nutrition Examination Survey (NHANES III) in the United States.[123]

Using the established ULs for fluoride, the amount of fluoride that may be consumed each day to reduce the risk of moderate dental fluorosis for children under eight, has been calculated by gender and age group (expressed as average weight). (See Table 3.)

As a practical example, daily intake of 2 mg of fluoride is adequate for a nine to 13-year-old child weighing 88 pounds (40 kg). This was calculated by multiplying 0.05 mg/kg/day (AI) times 40 kg (weight) to equal 2 mg. At the same time, that 88 pound (40kg) child could consume 10 mg of fluoride a day as a tolerable upper intake level.

Children living in a community with water fluoridation get a portion of their daily fluoride intake from fluoridated water and a portion from dietary sources which would include food and other beverages. When considering water fluoridation, an individual must consume one liter of water fluoridated at 1 part per million (1 ppm) to receive 1 milligram (1 mg) of fluoride.[42,178] Children under six years of age, on average, consume less than one-half liter of drinking water a day.[178] Therefore, children under six years of age would consume, on average, less than 0.5 mg of fluoride a day from drinking optimally fluoridated water (at 1 ppm).

If a child lives in a nonfluoridated area, the dentist or physician may prescribe dietary fluoride supplements. As shown in Table 1 "Dietary Fluoride Supplement Schedule 1994" (See Question 12), the current dosage schedule recommends supplemental fluoride amounts that are below the AI for each age group. The dosage schedule was designed to offer the benefit of decay reduction with margin of safety to prevent mild to moderate dental fluorosis. For example, the AI for a child 3 years of age is 0.7 mg/day. The recommended dietary fluoride supplement dosage for a child 3 years of age in a nonfluoridated community is 0.5 mg/day. This provides leeway for some fluoride intake from processed food and beverages, and other sources.

Decay rates are declining in many population groups because children today are being exposed to fluoride from a wider variety of sources than decades ago. Many of these sources are intended for topical use only; however, some fluoride is ingested inadvertently by children.[183] Inappropriate ingestion of fluoride can be prevented, thus reducing the risk for dental fluorosis without jeopardizing the benefits to oral health.

For example, it has been reported in a number of studies that young children inadvertantly swallow an average of 0.30 mg of fluoride from fluoride toothpaste at each brushing.[184,185-189] If a child brushes twice a day, 0.60 mg may be ingested inappropriately. This may slightly exceed the Adequate Intake (AI) values from Table 3. The 0.60 mg consumption is 0.10 mg higher than the AI value for children 6 to 12 months and is 0.10 mg lower than the AI for children from 1-3 years of age.[123] Although toothpaste is not meant to be swallowed, children may consume the daily recommended Adequate Intake amount of fluoride from toothpaste alone. In order to decrease the risk of dental fluorosis, the American Dental Association since 1992 has recommended that parents and caregivers put only one pea-sized amount of fluoride toothpaste on a young child's toothbrush at each brushing. Also, young children should be supervised while brushing and taught to spit out, rather than swallow, the toothpaste. Consult with your child's dentist or physician if you are considering using fluoride toothpaste before age two.

Additional information on this topic may be found in Question 25.

It should be noted that the amounts of fluoride discussed here are intake, or ingested, amounts. When fluoride is ingested, a portion is retained in the body and a portion is excreted. This issue will be discussed further in Question 22.

QUESTION 21.

Is there a need for prenatal dietary fluoride supplementation?

Answer.

There is no scientific basis to suggest any need to increase a woman's daily fluoride intake during pregnancy or breastfeeding to protect her health. At this time, scientific evidence is insufficient to support the recommendation for prenatal fluoride supplementation for decay prevention for infants.[123,190]

Fact.

The Institute of Medicine has determined that, "No data from human studies document the metabolism of fluoride during lactation. Because fluoride concentrations in human milk are very low (0.007 to 0.011 ppm) and relatively insensitive to differences in the fluoride concentrations of the mother's drinking water, fluoride supplementation during lactation would not be expected to significantly affect fluoride intake by the nursing infant or the fluoride requirement of the mother."[123]

The authors of the only prospective, randomized, double blind study to evaluate the effectiveness of prenatal dietary supplementation have concluded that the data do not support the hypothesis that prenatal fluoride has a strong decay preventive effect.[190] Moreover, prenatal dietary fluoride supplementation will not have an affect on the baby's permanent teeth because permanent teeth do not begin to develop during pregnancy.[191]

QUESTION 22.

When fluoride is ingested, where does it go?

Answer.

Much of the fluoride is excreted. Of the fluoride retained, almost all is found in calcified (hard) tissues, such as bones and teeth. Fluoride helps to prevent dental decay when incorporated into the teeth.

Fact.

After ingestion of fluoride, such as drinking a glass of optimally fluoridated water, the majority of the fluoride is absorbed from the stomach and small intestine into the blood stream.[192] This causes a short term increase in fluoride levels in the blood. The fluoride levels increase quickly and reach a peak concentration within 20-60 minutes.[193] The concentration declines rapidly, usually within three to six hours following peak levels, due to the uptake of fluoride by calcified tissues and efficient removal of fluoride by the kidneys.[182] Approximately 50% of the fluoride absorbed each day by young or middle-aged adults becomes associated with hard tissues within 24 hours while virtually all of the remainder is excreted in the urine. Approximately 99% of the fluoride present in the body is associated with hard tissues.[192]

Ingested or systemic fluoride becomes incorporated into forming tooth structures. Fluoride ingested regularly during the time when teeth are developing is deposited throughout the entire surface of the tooth and contributes to long lasting protection against dental decay.[42]

Additional information on this topic may be found in Question 2.

An individual's age and stage of skeletal development will affect the rate of fluoride retention.The amount of fluoride taken up by bone and retained in the body is inversely related to age. More fluoride is retained in young bones than in the bones of older adults.[183,192,193]

According to generally accepted scientific knowledge, the ingestion of optimally fluoridated water does not have an adverse effect on bone health.[194-198] Evidence of advanced skeletal fluorosis, or crippling skeletal fluorosis, "was not seen in communities in the United States where water supplies contained up to 20 ppm (natural levels of fluoride)."[123,199] In these communities, daily fluoride intake of 20 mg/day would not be uncommon.[123] Crippling skeletal fluorosis is extremely rare in the United States and is not associated with optimally fluoridated water; only 5 cases have been confirmed during the last 35 years.[123]

Additional information on this topic may be found in Question 23.

The kidneys play the major role in the removal of fluoride from the body. Normally kidneys are very efficient and excrete fluoride very rapidly. However, decreased fluoride removal may occur among persons with severely impaired kidney function who may not be on kidney dialysis.[167] No cases of dental fluorosis or symptomatic skeletal fluorosis have been reported among persons with impaired kidney function; however, the overall health significance of reduced fluoride removal is uncertain and continued follow-up is recommended especially for children with impaired kidney function.[84]

Additional information on this topic may be found in Question 40.

QUESTION 23.

Will the ingestion of optimally fluoridated water over a lifetime adversely affect bone health?

Answer.

No, the ingestion of optimally fluoridated water does not have an adverse effect on bone health.[194-198,203-205]

Fact.

The weight of scientific evidence does not provide an adequate basis for altering public health policy regarding fluoridation because of bone health concerns. A number of investigations have studied the effects on bone structure of individuals residing in communities with optimal and higher than optimal concentrations of fluoride in the drinking water. These studies have focused on whether there exists a possible link between fluoride and bone fractures. Additionally, the possible association between fluoride and bone cancer has been studied.

In 1991, a workshop, co-sponsored by the National Institute of Arthritis and Musculoskeletal and Skin Diseases and the then National Institute of Dental Research, addressed the potential relationship of hip fracture and bone health in humans to fluoride exposure from drinking water. Meeting at the National Institutes of Health, researchers examined historic and contemporary research on fluoride exposure and bone health. At that time, participants concluded there was no basis for altering current public health policy regarding current guidelines for levels of fluoride in drinking water. Recommendations were made regarding additional research in several areas.[194]

In 1993, two studies were published demonstrating that exposure to fluoridated water does not contribute to an increased risk for hip fractures. One study looked at the risk of hip fractures in residents of two similar communities in Alberta, Canada.[195] In this study, researchers compared a city with fluoridated drinking water optimally adjusted to 1 ppm to a city whose residents drank water containing naturally occurring fluoride at a concentration of only 0.3 ppm. No significant difference was observed in the overall hip fracture hospitalization rates for residents of both cities. "These findings suggest that fluoridation of drinking water has no impact, neither beneficial nor deleterious, on the risk of hip fracture."[195]

The second study examined the incidence of hip fracture rates before and after water fluoridation in Rochester, Minnesota.[196] Researchers compared the hip fracture rates of men and women aged 50 and older from 1950 to 1959 (before the city's water supply was fluoridated in 1960) with the ten-year period after fluoridation. Their findings showed that hip fracture rates had decreased, and that the decrease began before fluoridation was introduced, and then continued. These data demonstrate no increase in the risk of hip fracture associated with water fluoridation.

An ecological study conducted in eastern Germany compared the incidence of hip fractures for adults living in Chemnitz (optimally fluoridated) and Halle (fluoride-deficient). The results suggested the consumption of optimally fluoridated water reduced the incidence of hip fractures in elderly individuals, especially women over 84 years of age.[200]

The ingestion of optimally fluoridated water does not have an adverse effect on bone health.[194-198,200] Exposure to fluoride at levels considered optimal for the prevention of dental decay appears to have no significant impact on bone mineral density or risk of bone fracture.[201-205] Some studies have reported hip fracture risk increased slightly, decreased slightly or was unchanged in fluoridated areas compared to nonfluoridated areas. A recent systematic review of these studies concluded there was no clear association with water fluoridation and hip fracture.[206]

"Exposure to fluoride at levels considered optimal for the prevention of dental decay appears to have no significant impact on bone mineral density or risk of bone fracture."

24.

While a number of studies reported findings at a population level, both the Hillier and Phipps studies examined risk on an individual rather than a community basis taking into account other risk factors such as medications, age of menopause, alcohol consumption, smoking, dietary calcium intake and physical activity. Using these more rigorous study designs, Hillier and Phipps reported no change or lower hip fracture risk in those drinking fluoridated water.[203,204]

In *Bone Health and Osteoporosis: A Report of the Surgeon General* issued in 2004, fluoride is listed as a nutrient that has potentially beneficial effects on bone.[207]

Lastly, the possible association between fluoride and bone cancer has been studied. In the early 1990s, two studies were conducted to evaluate the carcinogenicity of sodium fluoride in laboratory animals. The first study was conducted by the National Toxicology Program (NTP) of the National Institute of Environmental Health Sciences.[208] The second study was sponsored by the Proctor and Gamble Company.[209] In both studies, higher than optimal concentrations of sodium fluoride (25, 100 and 175 ppm) were consumed by rats and mice. When the NTP and the Proctor and Gamble studies were combined, a total of eight individual sex/species groups became available for analysis. Seven of these groups showed no significant evidence of malignant tumor formation. One group, male rats from the NTP study, showed "equivocal" evidence of carcinogenicity, which is defined by NTP as a marginal increase in neoplasms – i.e., osteosarcomas (malignant tumors of the bone) – that may be chemically related. The Ad Hoc Subcommittee on Fluoride of the U.S. Public Health Service combined the results of the two studies and stated: "Taken together, the two animal studies available at this time fail to establish an association between fluoride and cancer."[84,210]

Additional information on this topic may be found in Question 28.

QUESTION 24.

What is dental fluorosis?

Answer.

Dental fluorosis is a change in the appearance of teeth and is caused when higher than optimal amounts of fluoride are ingested in early childhood while tooth enamel is forming. The risk of dental fluorosis can be greatly reduced by closely monitoring the proper use of fluoride products by young children.

Fact.

Dental fluorosis is caused by a disruption in enamel formation which occurs during tooth development in early childhood related to a higher than optimal intake of fluoride .[182] Enamel formation of permanent teeth, other than third molars (wisdom teeth), occurs from about the time of birth until approximately five years of age. After tooth enamel is completely formed, dental fluorosis cannot develop even if excessive fluoride is ingested.[211] Older children and adults are not at risk for the development of dental fluorosis. Dental fluorosis becomes apparent only after the teeth erupt. Because dental fluorosis occurs while teeth are forming under the gums, teeth that have erupted are not at risk for dental fluorosis. It should be noted that many other developmental changes that affect the appearance of tooth enamel are not related to fluoride intake.

Table 4. Dental Fluorosis Classification by H.T. Dean–1942[212]

Classification	Criteria–Description of Enamel
Normal	Smooth, glossy, pale creamy-white translucent surface
Questionable	A few white flecks or white spots
Very Mild	Small opaque, paper-white areas covering less than 25% of the tooth surface
Mild	Opaque white areas covering less than 50% of the tooth surface
Moderate	All tooth surfaces affected; marked wear on biting surfaces; brown stain may be present
Severe	All tooth surfaces affected; discrete or confluent pitting; brown stain present

Dental fluorosis has been classified in a number of ways. One of the most universally accepted classifications was developed by H. T. Dean in 1942; its descriptions can be easily visualized by the public (see Table 4).[212]

In using Dean's Fluorosis Index, each tooth present in an individual's mouth is rated according to the fluorosis index in Table 4. The individual's fluorosis score is based upon the severest form of fluorosis recorded for two or more teeth. Dean's Index, which has been used for more than 60 years, remains popular for prevalence studies in large part due to its simplicity and the ability to make comparisons with findings from a number of earlier studies.[213]

Very mild to mild fluorosis has no effect on tooth function and may make the tooth enamel more resistant to decay. These types of fluorosis are not readily apparent to the affected individual or casual observer and often require a trained specialist to detect. In contrast, the moderate and severe forms of dental fluorosis, characterized by esthetically (cosmetically) objectionable changes in tooth color and surface irregularities, are typically easy to detect. Most investigators regard even the more advanced forms of dental fluorosis as a cosmetic effect rather than a functional adverse effect.[123] The U.S. Environmental Protection Agency, in a decision supported by the U.S. Surgeon General, has determined that objectionable dental fluorosis is a cosmetic effect with no known health effects.[168] Little research on the psychological effects of dental fluorosis on children and adults has been conducted, perhaps because the majority of those who have the milder forms of dental fluorosis are unaware of this condition.[84]

In a 1986-7 national survey of U.S. school children conducted by the National Institute of Dental Research (NIDR), dental fluorosis was present in 22.3% of the children examined using Dean's Index.[84] These children were exposed to a variety of sources of fluoride (fluoridated water, food, beverages, fluoride dental products and dietary supplements). The prevalence of the types of dental fluorosis observed was:

Very mild fluorosis	17.0%
Mild fluorosis	4.0%
Moderate fluorosis	1.0%
Severe fluorosis	0.3%
Total	22.3%

The incidence of moderate or severe fluorosis comprised a very small portion (6%) of the total amount of fluorosis. In other words, 94% of all dental fluorosis was the very mild to mild form of dental fluorosis.

This survey conducted by NIDR remains the only source of national data regarding the prevalence of dental fluorosis. In a study that compared this data with data recorded by H. Trendley Dean in the 1930s, it was determined that the greatest increase in fluorosis from the 1930s to the 1980s appeared in the group with suboptimally fluoridated water. During the last ten years of this period, children were exposed to fluoride from multiple sources including water, infant formula, foods, foods and drinks prepared with fluoridated water as well as dietary supplements and the ingestion of fluoride toothpaste making it difficult to pinpoint the effect any one item had on the development of fluorosis. As part of the most recent National Health and Nutrition Examination Survey (NHANES) 1999-2002, new fluorosis data has been collected as a representative sample of the U.S. population. By comparing NIDR and the latest NHANES data, researchers will be able to determine trends in the prevalence and severity of dental fluorosis in the past 15 years and examine if changes in exposure to systemic fluorides such as infant formulas, toothpaste and dietary fluoride supplements have had some effect.[214]

Using the same NIDR study, researchers looked at children aged 12-14 years who had never received dietary fluoride supplements and had only lived in one home. Through their analysis, they found that approximately 2% of U.S. school children may experience perceived esthetic problems which could be attributed to the currently recommended levels of fluoride in drinking water. They reported that dental fluorosis in the esthetically important front teeth occurs less often and is less severe than when looking at all teeth in an individual. While the researchers were not able to provide a cost estimate associated with the treatment of this fluorosis, they did note that such estimates are frequently an overestimation of the actual costs. Additionally, any change recommended to the current fluoridation policy would need to be weighed against fluoridation's lifetime benefits and the feasibility and associated costs of alternative solutions.[215]

As with other nutrients, fluoride is safe and effective when used and consumed properly. The recommended optimum water fluoride concentration of 0.7 to 1.2 ppm was established to maximize the decay preventive benefits of fluoride, and the same time minimize the likelihood of mild dental fluorosis.[84]

"The risk of teeth forming with the very mildest form of fluorosis must be weighed against the benefit that the individual's teeth will also have a lower level of dental decay thus saving dental treatment costs, patient discomfort and tooth loss."

The benefits and risks of community water fluoridation have been examined and are discussed extensively in the Benefits Section and the safety of water fluoridation is discussed in great detail in the remainder of this (Safety) Section of this document. In assessing the risks of dental fluorosis, scientific evidence indicates it is probable that approximately 10% of children consuming optimally fluoridated water, in the absence of fluoride from all other sources, will develop very mild dental fluorosis.[10] As defined in Table 4, very mild fluorosis is characterized by small opaque, paper-white area covering less than 25% of the tooth surface. The risk of teeth forming with the very

mildest form of fluorosis must be weighed against the benefit that the individual's teeth will also have a lower level of dental decay thus saving dental treatment costs, patient discomfort and tooth loss.[11,12] In addition, the risk of fluorosis may be viewed as an alternative to having dental decay, which is a disease that may cause cosmetic problems much greater than dental fluorosis.[216]

In 1994, a review of five recent studies indicated that the amount of dental fluorosis attributable to water fluoridation was approximately 13%. This represents the amount of fluorosis that might be eliminated if community water fluoridation was discontinued.[85] In other words, the majority of dental fluorosis can be associated with other risk factors such as the inappropriate ingestion of fluoride products.

Additional information on this topic may be found in Question 25.

The type of fluorosis seen today remains largely limited to the very mild and mild categories; however, the prevalence of dental fluorosis in both fluoridated and nonfluoridated communities in the United States is higher than it was when the original epidemiological studies were conducted approximately 60 years ago.[84] The inappropriate use of fluoride-containing dental products is the largest risk factor for increased fluorosis as fluoride intake from food and beverages has remained constant over time.[180,181] The risk of fluorosis can be greatly reduced by following label directions for the use of these fluoride products.[123,167]

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Additional information on this topic may be found in Question 25.

QUESTION 25.

What can be done to reduce the occurrence of dental fluorosis in the U.S.?

Answer.

The vast majority of dental fluorosis in the United States can be prevented by limiting the ingestion of topical fluoride products (such as toothpaste) and the appropriate use of dietary fluoride supplements without denying young children the decay prevention benefits of community water fluoridation.

Fact.

During the period of enamel formation in young children (before teeth appear in the mouth), inappropriate ingestion of high levels of fluoride is the risk factor for dental fluorosis.[85,217] Studies of fluoride intake from the diet including foods, beverages and water indicate that fluoride ingestion from these sources has remained relatively constant for over half a century and, therefore, is not likely to be associated with an observed increase in dental fluorosis.[180-182]

Additional information on this topic may be found in Question 19.

Dental decay has decreased because children today are being exposed to fluoride from a wider variety of sources than decades ago. Many of these sources are intended for topical use only; however, some fluoride is ingested inadvertently by children.[183] Inappropriate ingestion of topical fluoride can be minimized, thus reducing the risk for dental fluorosis without reducing decay prevention benefits.

Since 1992, the American Dental Association (ADA) has required manufacturers of toothpaste to include the phrase **"Use only a pea-sized amount (of toothpaste) for children under six"** on fluoride toothpaste labels with the ADA Seal of Acceptance. The rationale for choosing six years of age for the toothpaste label is based on the fact that the swallowing reflex is not fully developed in children of preschool age and they may inadvertently swallow toothpaste during brushing. In addition, the enamel formation of permanent teeth is basically complete at six and so there is a decreased risk of fluorosis. Because dental fluorosis occurs while teeth are forming under the gums, individuals whose teeth have erupted are not at risk for dental fluorosis.

Additional information on this topic may be found in Question 24.

Numerous studies have established a direct relationship between young children brushing with more than a pea-sized amount of fluoride toothpaste and the risk of very mild or mild dental fluorosis in both fluoridated and nonfluoridated communities.[189,218,219] It was noted that 34% of the dental fluorosis cases in a nonfluoridated community were explained by children having brushed more than once per day during the first two years of life. In the optimally fluoridated community, 68% of the fluorosis cases were explained by the children using more than a pea-sized amount of toothpaste during the first year of life.[220] **Parents and caregivers should put only one pea-sized amount of fluoride toothpaste on a young child's toothbrush at each brushing. Young children should be supervised while brushing and taught to spit out, rather than swallow, the toothpaste. Consult with your child's dentist or physician if you are considering using fluoride toothpaste before age two.**

Additionally, it has been shown that 65% of the fluorosis cases in a nonfluoridated area were attributed to fluoride supplementation under the pre-1994 protocol. Thirteen percent of fluorosis cases in a fluoridated community could be explained by a history of taking dietary fluoride supplements inappropriately.[220] Dietary fluoride supplements should be prescribed as recommended in the dietary fluoride supplement schedule approved by the American Dental Association, the American Academy of Pediatrics and the American Academy of Pediatric Dentistry in 1994 (see Table 1).[30,125] **Fluoride supplements should only be prescribed for children living in nonfluoridated areas.** Because of many sources of fluoride in the diet, proper prescribing of fluoride supplements can be complex. It is suggested that all sources of fluoride be evaluated with a thorough fluoride history before supplements are prescribed for a child.[122] That evaluation should include testing of the home water supply if the fluoride concentration is unknown.

Additional information on this topic may be found in Question 42.

Parents, caretakers and health care professionals should judiciously monitor use of all fluoride-containing dental products by children under age six. As is the case with any therapeutic product, more is not always better. Care should be taken to adhere to label directions on fluoride prescriptions and over-the-counter products (e.g. fluoride toothpastes and rinses). **The ADA recommends the use of fluoride mouthrinses, but not for children under six years of age because they may swallow the rinse.** These products should be stored out of the reach of children.

Finally, in areas where naturally occurring fluoride levels in ground water are higher than 2 ppm, consumers should consider action to lower the risk of dental fluorosis for young children. (Adults are not affected because dental fluorosis occurs only when developing teeth are exposed to elevated fluoride levels.) Families on community water systems should contact their water supplier to ask about the fluoride level. Consumers with private wells should have the source tested yearly to accurately determine the fluoride content. Consumers should consult with their dentist regarding water testing and discuss appropriate dental health care measures. In homes where young children are consuming water with a fluoride level greater than 2 ppm, families should use an alternative primary water source, such as bottled water, for drinking and cooking. It is also important to remember that the ADA recommends dietary fluoride supplements only for children living in areas with less than optimally fluoridated water.

Additional information on this topic may be found in Questions 4, 12 and 42.

QUESTION 26.

Why is there a warning label on a tube of fluoride toothpaste?

Answer.

The American Dental Association originally required manufacturers to place a label on fluoride toothpaste in 1991 to ensure proper use and therefore reduce the risk of dental fluorosis.

Fact.

In 1991, the American Dental Association (ADA) began requiring toothpaste manufacturers to include the following language on all ADA-Accepted toothpastes: "Do not swallow. Use only a pea-sized amount for children under six. To prevent swallowing, children under six years of age should be supervised in the use of toothpaste."

"To ensure children's safety, the ADA limits the total amount of fluoride allowed in ADA-Accepted toothpaste."

The ADA warning labels were adopted to help reduce the risk of mild dental fluorosis. This type of fluorosis is not readily apparent to the affected individual or casual observer and often requires a trained specialist to detect. Dental fluorosis only occurs when more than the optimal daily amount of fluoride is ingested.

Additionally, to ensure children's safety, the ADA limits the total amount of fluoride allowed in any one tube of ADA-Accepted toothpaste.

Since 1997, the U.S. Food and Drug Administration (FDA) has required the label language, "If you accidentally swallow more than used for brushing, seek professional help or contact a poison control center immediately" on all fluoride toothpastes sold in the U.S.

The new FDA labels are consistent with the ADA statements, with the exception of the poison control warning.

The ADA Council on Scientific Affairs believes that the last sentence on the label could unnecessarily frighten parents and children and that this portion of the label overstates any demonstrated or potential danger posed by fluoride toothpastes.

The ADA notes that a child could not absorb enough fluoride from one tube of toothpaste to cause a serious problem and that the excellent safety record on fluoride toothpaste argues against any unnecessary regulation.[221]

QUESTION 27.

Is fluoride, as provided by community water fluoridation, a toxic substance?

Answer.

No. Fluoride, at the concentrations found in optimally fluoridated water, is not toxic according to generally accepted scientific knowledge.

Fact.

Like many common substances essential to life and good health – salt, iron, vitamins A and D, chlorine, oxygen and even water itself – fluoride can be toxic in excessive quantities. Fluoride in the much lower concentrations (0.7 to 1.2 ppm) used in water fluoridation is not harmful or toxic.

Acute fluoride toxicity occurring from the ingestion of optimally fluoridated water is impossible.[182] The amount of fluoride necessary to cause death for a human adult (155 pound man) has been estimated to be 5-10 grams of sodium fluoride, ingested at one time.[222] This is more than 10,000-20,000 times as much fluoride as is consumed at one time in a single 8 ounce glass of optimally fluoridated water.

Chronic fluoride toxicity may develop after 10 or more years of exposure to very high levels of fluoride, levels not associated with optimal fluoride intake in drinking water. The primary functional adverse effect associated with long term excess fluoride intake is

skeletal fluorosis. The development of skeletal fluorosis and its severity is directly related to the level and duration of fluoride exposure. For example, the ingestion of water naturally fluoridated at approximately 5 ppm for 10 years or more is needed to produce clinical signs of osteosclerosis (a mild form of skeletal fluorosis that can be seen as a change in bone density on x-rays) in the general population. In areas naturally fluoridated at 5 ppm, daily fluoride intake of 10 mg/day would not be uncommon.[123] A survey of X-rays from 170,000 people in Texas and Oklahoma whose drinking water had naturally occurring fluoride levels of 4 to 8 ppm revealed only 23 cases of osteosclerosis and no cases of crippling skeletal fluorosis.[223] Evidence of advanced skeletal fluorosis, or crippling skeletal fluorosis, "was not seen in communities in the United States where water supplies contained up to 20 ppm (natural levels of fluoride)."[123,199] In these communities, daily fluoride intake of 20mg/day would not be uncommon.[123] Crippling skeletal fluorosis is extremely rare in the United States and is not associated with optimally fluoridated water; only 5 cases have been confirmed during the last 35 years.[123]

Additional information on this topic may be found in Question 20.

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The Agency for Toxic Substances and Disease Registry (ATSDR) prepares toxicological profiles for various hazardous substances most commonly found at facilities on the CERCLA National Priorities List (Superfund Sites). The *Toxicological Profile for Fluorides, Hydrogen Fluoride and Fluorine* was revised in 2003. The ATSDR states that existing data indicates that subsets of the population may be unusually susceptible to the toxic effects of fluoride and its compounds at high doses. However, there are no data to suggest that exposure to the low levels associated with community water fluoridation would result in adverse effects in these potentially susceptible populations.[224]

> *"The possibility of adverse health effects from continuous low level consumption of fluoride over long periods has been studied extensively. As with other nutrients, fluoride is safe and effective when used and consumed properly."*

The possibility of adverse health effects from continuous low level consumption of fluoride over long periods has been studied extensively. As with other nutrients, fluoride is safe and effective when used and consumed properly. No charge against the benefits and safety of fluoridation has ever been substantiated by generally accepted scientific knowledge. After 60 years of research and practical experience, the preponderance of scientific evidence indicates that fluoridation of community water supplies is both safe and effective.

At one time, high concentrations of fluoride additives were used in insecticides and rodenticides.[36] Today fluoride additives are rarely used in pesticides because more effective additives have been developed.[183]

While large doses of fluoride may be toxic, it is important to recognize the difference in the effect of a massive dose of an extremely high level of fluoride versus the recommended amount of fluoride found in optimally fluoridated water. The implication that fluorides in large doses and in trace amounts have the same effect is completely unfounded. Many substances in widespread use are very beneficial in small amounts, but may be harmful in large doses – such as salt, chlorine and even water itself.

QUESTION 28.

Does drinking optimally fluoridated water cause or accelerate the growth of cancer?

Answer.

According to generally accepted scientific knowledge, there is no association between cancer rates in humans and optimal levels of fluoride in drinking water.[225]

Fact.

Since community water fluoridation was introduced in 1945, more than 50 epidemiologic studies in different populations and at different times have failed to demonstrate an association between fluoridation and the risk of cancer.[84] Studies have been conducted in the United States,[226-231] Japan,[232] the United Kingdom,[233-235] Canada[236] and Australia.[237] In addition, several independent bodies have conducted extensive reviews of the scientific literature and concluded that there is no relationship between fluoridation and cancer.[84,163,165,176,206,238]

The U.S. Environmental Protection Agency (EPA) further commented on the safety of appropriate fluoride exposure in the December 5, 1997, *Federal Register*.[239] In a notice of a final rule relating to fluoride additives; the EPA stated, "…the weight of evidence from more than 50 epidemiological studies does not support the hypothesis of an association between fluoride exposure and increased cancer risk in humans. The EPA is in agreement with the conclusions reached by the National Academy of Sciences (NAS)."

Despite the abundance of scientific evidence to the contrary, claims of a link between fluoridation and increased cancer rates continue. This assertion is largely based on one study comparing cancer death rates in ten large fluoridated cities versus ten large nonfluoridated cities in the United States. The results of this study have been refuted by a number of organizations and researchers.[240] Scientists at the National Cancer Institute analyzed the same data and found that the original investigators failed to adjust their findings for variables, such as age and gender differences, that affect cancer rates. A review by other researchers pointed to further shortcomings in

the study. The level of industrialization in the fluoridated cities was much higher than the nonfluoridated cities. Researchers noted that a higher level of industrialization is usually accompanied by a higher incidence of cancer. While the researchers noted that the fluoridated cities did have higher cancer rates over the twenty year study, the rate of increase in the nonfluoridated cities was exactly the same (15%) as the fluoridated cities. Following further reviews of the study, the consensus of the scientific community continues to support the conclusion that the incidence of cancer is unrelated to the introduction and duration of water fluoridation.[84]

In the early 1990s, two studies using higher than optimal levels of fluoride were conducted to evaluate the carcinogenicity of sodium fluoride in laboratory animals. The first study was conducted by the National Toxicology Program (NTP) of the National Institute of Environmental Health Sciences.[208] The second study was sponsored by the Proctor and Gamble Company.[209] In both studies, higher than optimal concentrations of sodium fluoride (25, 100 and 175 ppm) were consumed by rats and mice. When the NTP and the Proctor and Gamble studies were combined, a total of eight individual sex/species groups became available for analysis. Seven of these groups showed no significant evidence of malignant tumor formation. One group, male rats from the NTP study, showed "equivocal" evidence of carcinogenicity, which is defined by NTP as a marginal increase in neoplasms – i.e., osteosarcomas (malignant tumors of the bone) – that may be chemically related. The Ad Hoc Subcommittee on Fluoride of the U.S. Public Health Service combined the results of the two studies and stated: "Taken together, the two animal studies available at this time fail to establish an association between fluoride and cancer."[84,210]

Since that time, a number of studies have examined the hypothesis that fluoride is a risk factor for bone cancer. None of these studies reported an association between optimal levels of fluoride in drinking water and cancer of the bone.[241-244]

Additional information on this topic may be found in Question 23.

In a 1990 study, scientists at the National Cancer Institute evaluated the relationship between fluoridation of drinking water and cancer deaths in the United States during a 36 year period, and the relationship between fluoridation and the cancer rate during a 15 year period. After examining more than 2.3 million cancer death records and 125,000 cancer case records in counties using fluoridated water, the researchers saw no indication of a cancer risk associated with fluoridated drinking water.[84]

In 2001, researchers from Japan analyzed data on cancers taken from the International Agency for Research on Cancer World Health Organization in 1987, 1992 and 1997 and concluded that fluoridation may increase the risk for numerous types of cancers.[245] However, the methodology used in this analysis was inherently flawed as there are major and obvious differences in a number of factors relevant to the risk for cancer in the fluoridated and nonfluoridated communities. For example, this analysis did not control for differences in urbanization, socioeconomic status, geographic region, occupations, industries, diet, medical practices or tobacco use between the fluoridated and nonfluoridated communities. Thus any attempt to interpret cancer risk between these communities with this number of uncontrolled variables is scientifically inappropriate.

> *"The American Cancer Society states, 'Scientific studies show no connection between cancer rates in humans and adding fluoride to drinking water.'"*

In a document entitled "Fluoride and Drinking Water Fluoridation," the American Cancer Society states, "Scientific studies show no connection between cancer rates in humans and adding fluoride to drinking water."[225]

QUESTION 29.

Does fluoride, as provided by community water fluoridation, inhibit the activity of enzymes in humans?

Answer.

Fluoride, in the amount provided through optimally fluoridated water, has no effect on human enzyme activity according to generally accepted scientific knowledge.

Fact.

Enzymes are organic compounds that promote chemical change in the body. Generally accepted scientific knowledge has not indicated that optimally fluoridated water has any influence on human enzyme activity. There are no available data to indicate that, in humans drinking optimally fluoridated water, the fluoride affects enzyme activities with toxic consequences.[246] The World Health Organization report, *Fluorides and Human Health* states, "No evidence has yet been provided that fluoride ingested at 1 ppm in the drinking water affects intermediary metabolism of food stuffs, vitamin utilization or either hormonal or enzymatic activity."[247]

The concentrations of fluoride used in laboratory studies to produce significant inhibition of enzymes are hundreds of times greater than the concentration present in body fluids or tissues.[222] While fluoride may affect enzymes in an artificial environment outside of a living organism in the laboratory, it is unlikely that adequate cellular levels of fluoride to alter enzyme activities would be attainable in a living organism.[251] The two primary physiological mechanisms that maintain a low concentration of fluoride ion in body fluids are the rapid excretion of fluoride by the kidneys and the uptake of fluoride by calcified tissues.

QUESTION 30.

Does the ingestion of optimally fluoridated water adversely affect the thyroid gland or its function?

Answer.

There is no scientific basis that shows fluoridated water has an adverse effect on the thyroid gland or its function.

Fact.

In an effort to determine if fluoride in drinking water affects the function, shape and size of the thyroid gland, researchers conducted a study comparing one group of people who consumed water that contained natural fluoride levels of 3.48 ppm and one group who consumed water with extremely low fluoride levels of 0.09 ppm. The researchers noted that all study participants had been residents of their respective communities for more than 10 years. The researchers concluded that prolonged ingestion of fluoride at levels above optimal to prevent dental decay had no effect on thyroid gland size or function. This conclusion was consistent with earlier animal studies.[248]

In addition, two studies have explored the association between fluoridated water and cancer of the thyroid gland. Both studies found no association between optimal levels of fluoride in drinking water and thyroid cancer.[226,249]

In an effort to link fluoride and decreased thyroid function, those opposed to fluoridation cite one small study from the 1950's in which 15 patients who had hyperthyroidism (an overactive thyroid) were given relative large amounts of sodium fluoride orally or by injection in an effort to inhibit the thyroid's function. The researchers concluded that efforts to treat hyperthyroidism with fluoride was successful only occasionally among persons subjected to massive doses of fluoride. This study does not support claims that low fluoride levels in drinking water would cause hypothyroidism (an underactive thyroid).[250]

QUESTION 31.

Does water fluoridation affect the pineal gland causing the early onset of puberty?

Answer.

Generally accepted science does not suggest that water fluoridation causes the early onset of puberty.

Fact.

The pineal gland is an endocrine gland located in the brain which produces melatonin.[251] Endocrine glands secrete their products into the bloodstream and body tissues and help regulate many kinds of body functions. The hormone, melatonin, plays a role in sleep, aging and reproduction.

A single researcher has published one study in a peer-reviewed scientific journal regarding fluoride accumulation in the pineal gland. The purpose of the study was to discover whether fluoride accumulates in the pineal gland of older adults. This limited study, conducted on only 11 cadavers whose average age at death was 82 years, indicated that fluoride deposited in the pineal gland was significantly linked to the amount of calcium in the pineal gland. It would not be unexpected to see higher levels of calcium in the pineal gland of older individuals as this would be considered part of a normal aging process. As discussed in Question 22, approximately 99% of the fluoride present in the body is associated with hard or calcified tissues.[192] The study concluded fluoride levels in the pineal gland were not indicators of long-term fluoride exposure.[252]

The same researcher has theorized in unpublished reports posted on the Internet that the accumulation of fluoride in children's pineal gland leads to an earlier onset of puberty. However, the researcher notes that there is no verification that fluoride accumulates in children's pineal glands. Moreover, a study conducted in Newburgh (fluoridated) and Kingston (non-fluoridated), New York found no statistical significance between the onset of menstruation for girls living in a fluoridated verses non-fluoridated area.[253]

QUESTION 32.

Can fluoride, at the levels found in optimally fluoridated drinking water, alter immune function or produce allergic reaction (hypersensitivity)?

Answer.

There is no scientific evidence of any adverse effect on specific immunity from fluoridation, nor have there been any confirmed reports of allergic reaction.[254]

Fact.

There is no scientific evidence linking problems with immune function such as HIV or AIDS (acquired immune deficiency syndrome) with community water fluoridation.[255]

There are no confirmed cases of allergy to fluoride, or of any positive skin testing in human or animal models.[254] A committee of the National Academy of Sciences evaluated clinical reports of possible allergic responses to fluoride and reported, "The reservation in accepting (claims of allergic reaction) at face value is the lack of similar reports in much larger numbers of people who have been exposed to considerably more fluoride than was involved in the original observations."[39] The World Health Organization also judged these cases to represent "a variety of unrelated conditions" and found no evidence of allergic reactions to fluoride.[256,257]

A 1996 review of the literature on fluoride and white cell function examined numerous studies and concluded that there is no evidence of any harmful effect on specific immunity following fluoridation nor any confirmed reports of allergic reactions.[254]

QUESTION 33.

Is fluoride, as provided by community water fluoridation, a genetic hazard?

Answer.

Following a review of generally accepted scientific knowledge, the National Research Council of the National Academy of Sciences supports the conclusion that drinking optimally fluoridated water is not a genetic hazard.[167]

Fact.

Chromosomes are the DNA-containing bodies of cells that are responsible for the determination and transmission of hereditary characteristics. Genes are the functional hereditary unit that occupies a fixed location on a chromosome. Many studies have examined the possible effects of fluoride on chromosome damage. While there are no published studies on the genotoxic (damage to DNA) effect of fluoride in humans, numerous studies have been done on mice.[167] These studies have shown no evidence that fluoride damages chromosomes in bone marrow or sperm cells even at fluoride levels 100 times higher than that in fluoridated water.[258-264] Another independent group of researchers reported a similar lack of fluoride-induced chromosomal damage to human white blood cells, which are especially sensitive to agents which cause genetic mutations. Not only did fluoride fail to damage chromosomes, it protected them against the effect of a known mutagen (an agent that causes changes in DNA).[265,266] The genotoxic effects of fluoride were also studied in hamster bone marrow cells and cultured hamster ovarian cells. Again, the results supported the conclusion that fluoride does not cause chromosomal damage, and therefore, was not a genetic hazard.[267] In further tests, fluoride has not caused genetic mutations in the most widely used bacterial mutagenesis assay (the Ames test) over a wide range of fluoride levels.[267-270]

The National Research Council (NRC) of the National Academy of Sciences supports the conclusion that drinking optimally fluoridated water is not a genetic hazard. In a statement summarizing its research, the NRC states, "in vitro data indicate that:

1) the genotoxicity of fluoride is limited primarily to doses much higher than those to which humans are exposed,
2) even at high doses, genotoxic effects are not always observed, and
3) the preponderance of the genotoxic effects that have been reported are of the types that probably are of no or negligible genetic significance."[167]

The lowest dose of fluoride reported to cause chromosomal changes in mammalian cells was approximately 170 times that found normally found in human cells in areas where drinking water is fluoridated, which indicates a large margin of safety.[167]

QUESTION 34.

Does fluoride at the levels found in water fluoridation affect human reproduction, fertility or birth rates?

Answer.

There is no credible, scientific evidence that fluoridation has an adverse effect on human reproduction, fertility or birth rates.

Fact.

Very high levels of fluoride intake have been associated with adverse effects on reproductive outcomes in many animal species. Based on these findings, it appears that fluoride concentrations associated with adverse reproductive effects in animals are far higher (100-200 ppm) than those to which human populations are exposed. Consequently, there is insufficient scientific basis on which to conclude that ingestion of fluoride at levels found in community water fluoridation (0.7 – 1.2 ppm) would have adverse effects on human reproduction.[167]

One human study compared county birth data with county fluoride levels greater than 3 ppm and attempted to show an association between high fluoride levels in drinking water and lower birth rates.[271] However, because of serious limitations in design and analysis, the investigation failed to demonstrate a positive correlation.[272]

A study examining the relative risk of stillbirths and congenital abnormalities (facial clefts and neural tube defects) found no evidence that fluoridation had any effect of these outcomes.[273]

The National Research Council (NRC) of the National Academy of Sciences (NAS) supports the conclusion that drinking optimally fluoridated water is not a genetic hazard.[167]

Additional information on this topic may be found in Question 33.

QUESTION 35.

Does drinking optimally fluoridated water cause an increase in the rate of children born with Down Syndrome?

Answer.

There is no known association between the consumption of optimally fluoridated drinking water and Down Syndrome.

Fact.

This question originally arose because of two studies published in 1956 and 1963 by a psychiatrist. Data collected in several Midwest states in 1956 formed the basis for his two articles published in French journals, purporting to prove a relationship between fluoride in the water and Down Syndrome.[274,275]

Experienced epidemiologists and dental researchers from the National Institute of Dental Research and

staff members of the National Institute of Mental Health have found serious shortcomings in the statistical procedures and designs of these two studies. Among the most serious inadequacies is the fact that conclusions were based on the fluoridation status of the communities where the mothers gave birth, rather than the status of the rural areas where many of the women lived during their pregnancies.[222] In addition, the number of Down Syndrome cases found in both fluoridated and nonfluoridated communities were much lower than the rates found in many other parts of the United States and the world, that casting doubt on the validity of findings.

The following paragraphs provide a summary of numerous studies that have been conducted which refute the conclusions of the 1956 studies.

A British physician reviewed vital statistics and records from institutions and school health officers, and talked with public health nurses and others caring for children with Down Syndrome. The findings noted no indication of any relationship between Down Syndrome and the level of fluoride in water consumed by the mothers.[276]

These findings were confirmed by a detailed study of approximately 2,500 Down Syndrome births in Massachusetts. A rate of 1.5 cases per 1,000 births was found in both fluoridated and nonfluoridated communities, providing strong evidence that fluoridation does not increase the risk of Down Syndrome.[277]

Another large population-based study with data relating to nearly 1.4 million births showed no association between water fluoridation and the incidence of congenital malformations including Down Syndrome.[278]

In 1980, a 25-year review of the prevalence of congenital malformations was conducted in Birmingham, England. Although Birmingham initiated fluoridation in 1964, no changes in the prevalence of children born with Down Syndrome occurred since that time.[279]

A comprehensive study of Down Syndrome births was conducted in 44 U.S. cities over a two-year period. Rates of Down Syndrome were comparable in both fluoridated and nonfluoridated cities.[280]

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QUESTION 36.

Does ingestion of optimally fluoridated water have any neurological impact?

Answer.

There is no generally accepted scientific evidence establishing a causal relationship between consumption of optimally fluoridated water and central nervous system disorders, attention deficit disorders or effects on intelligence.

Fact.

There have been claims that exposure to fluoride presents a neurotoxic (harmful or damaging to nerve tissue) risk or lowered intelligence. Such claims are based partly on one 1995 study in which rats were fed fluoride at levels up to 125 times greater than that found in optimally fluoridated water.[281] The study attempted to demonstrate that rats fed extremely high levels of fluoride (75 ppm to 125 ppm in drinking water) showed behavior-specific changes related to cognitive deficits.

In addition, the experiment also studied the offspring of rats who were injected two to three times a day with fluoride during their pregnancies in an effort to show that prenatal exposure resulted in hyperactivity in male offspring.

However, two scientists who reviewed the 1995 study[282] have suggested that the observations made can be readily explained by mechanisms that do not involve neurotoxicity. The scientists found inadequacies in experimental design that may have led to invalid conclusions. For example, the results of the experiment were not confirmed by the use of control groups which are an essential feature of test validation and experimental design. In summary the scientists stated, "We do not believe the study by Mullenix et al. can be interpreted in any way as indicating the potential for NaF (sodium fluoride) to be a neurotoxicant." Another reviewer[182] noted, "...it seems more likely that the unusually high brain fluoride concentrations reported in Mullenix et al. were the result of some analytical error."

"A seven-year study compared the health and behavior of children from birth through six years of age in communities with optimally fluoridated water ...The results suggested that there was no evidence to indicate that exposure to optimally fluoridated water had any detectable effect on children's health or behavior."

A seven-year study compared the health and behavior of children from birth through six years of age in communities with optimally fluoridated water with those of children the same age without exposure to optimally fluoridated water. Medical records were reviewed yearly during the study. At age six and seven, child behavior was measured using both maternal and teacher ratings. The results suggested that there was no evidence to indicate that exposure to optimally fluoridated water had any detectable effect on children's health or behavior. These results did not differ even when data was controlled for family social background.[282]

The research conducted by Mullenix et al discussed in this question has not been replicated by other researchers.

Additional information on how to critically review research can be found in the Introduction and Figure 1.

QUESTION 37.

Does drinking fluoridated water increase the level of lead in the blood or cause lead poisoning in children?

Answer.

Generally accepted scientific evidence has not shown any association between water fluoridation and blood lead levels.

Fact.

One set of researchers has claimed that the silicofluoride additives used in community water fluoridation may be responsible for acidic drinking water which leaches lead from plumbing systems thereby increasing lead uptake by children. They go on to theorize that communities that use the silicofluorides have greater numbers of children with high levels of lead in their blood than nonfluoridated communities and that the results of the use of silicofluorides are reflected in these communities' residents exhibiting higher rates of learning disabilities, attention deficit disorders, violent crimes and criminals who were using cocaine at the time of arrest.[284]

From his research, Masters has claimed to be able to predict the estimated cost of increased prison populations due to water fluoridation. For example, in a 2003 appearance before the Palm Beach County (Florida) Commission, Masters stated that if the county fluoridated with silicofluorides, they could expect an additional 819 violent crimes per year directly related to water fluoridation with a minimum additional annual cost of imprisonment of $14,391,255.[284]

Scientists from the Environmental Protection Agency (EPA) have reviewed the basic science that was the foundation for the claim that silicofluorides leach lead from plumbing systems and found that many of the chemical assumptions made and statistical methods utilized in the original ecological study were scientifically unjustified. They went on to state that the research was inconsistent with accepted scientific knowledge and the authors of the original studies (Masters et al) failed to identify or account for these inconsistencies. Overall, the EPA scientists concluded that "no credible evidence exists to show that water fluoridation has any quantitatable effects on the solubility, bioavailability, bioaccumulation, or reactivity of lead (0) or lead (II) compounds.[285]

According to the Centers for Disease Control and Prevention, the average blood lead levels of young children in the U.S. have continued to decline since the 1970s primarily due to the phase-out of leaded gasoline and the resulting decrease in lead emissions. The primary remaining sources of childhood lead exposure are deteriorated leaded paint, house dust contaminated by leaded paint and soil contaminated by both leaded paint and decades of industrial and motor vehicle emissions.[286] Approximately 95% of the primary sources of adult lead exposure are occupational. Adult blood lead levels have continued to decline over the last ten years due largely to improved prevention measures in the workplace and changes in employment patters.[287] It should be noted that since the 1970s, while blood lead levels have continued to decline, the percentage of the population receiving optimally fluoridated water has continued to increase.[34]

The research conducted by Masters et al discussed in this question has not been replicated by other researchers.

Additional information on how to critically review research can be found in the Introduction and Figure 1.

QUESTION 38.

Does drinking optimally fluoridated water cause Alzheimer's disease?

Answer.

Generally accepted science has not demonstrated an association between drinking optimally fluoridated water and Alzheimer's disease.

Fact.

The exact cause of Alzheimer's disease has yet to be identified. Scientists have identified the major risk factors for Alzheimer's as age and family history. Scientists believe that genetics may play a role in many Alzheimer's cases. Other possible risk factors that are being studied are level of education, diet, environment and viruses to learn what role they might play in the development of this disease.[288]

A study published in 1998[289] raised concerns about the potential relationship between fluoride and Alzheimer's disease. However, several flaws in the experimental design preclude any definitive conclusions from being drawn.[290]

Interestingly, there is evidence that aluminum and fluoride are mutually antagonistic in competing for absorption in the human body.[42,291] While a conclusion cannot be made that consumption of fluoridated water has a preventive effect on Alzheimer's, there is no generally accepted scientific knowledge to show consumption of optimally fluoridated water is a risk factor for Alzheimer's disease.

QUESTION 39.

Does drinking optimally fluoridated water cause or contribute to heart disease?

Answer.

Drinking optimally fluoridated water is not a risk factor for heart disease.

Fact.

This conclusion is supported by results of a study conducted by the National Heart and Lung and Blood Institute of the National Institutes of Health. Researchers examined a wide range of data from communities that have optimally fluoridated water and from areas with insufficient fluoride.The final report concluded that:

> "Thus, the evidence from comparison of the health of fluoridating and nonfluoridating cities, from medical and pathological examination of persons exposed to a lifetime of naturally occurring fluorides or persons with high industrial exposures, and from broad national experience with fluoridation all consistently indicate no adverse effect on cardiovascular health."[292]

39.
40.
41.

"The American Heart Association states: 'No evidence exists that adjusting the fluoride content of public water supplies to a level of about one part per million has any harmful effect on the cardiovascular system.'"

The American Heart Association states: "No evidence exists that adjusting the fluoride content of public water supplies to a level of about one part per million has any harmful effect on the cardiovascular system."[293] The American Heart Association identifies aging, male sex, heredity, cigarette and tobacco smoke, high blood cholesterol levels, high blood pressure, physical inactivity, obesity and diabetes mellitus as major risk factors for cardiovascular disease.[294]

A number of studies have considered trends in urban mortality in relation to fluoridation status. In one study, the mortality trends from 1950-70 were studied for 473 cities in the United States with populations of 25,000 or more. Findings showed no relationship between fluoridation and heart disease death rates over the 20-year period.[228] In another study, the mortality rates for approximately 30 million people in 24 fluoridated cities were compared with those of 22 nonfluoridated cities for two years. No evidence was found of any harmful health effects, including heart disease, attributable to fluoridation. As in other studies, crude differences in the mortality experience of the cities with fluoridated and nonfluoridated water supplies were explainable by differences in age, gender and race composition.[227]

QUESTION 40.

Is the consumption of optimally fluoridated water harmful to kidneys?

Answer.

The consumption of optimally fluoridated water has not been shown to cause or worsen human kidney disease.

Fact.

Approximately 50% of the fluoride ingested daily is removed from the body by the kidneys.[182,192,193] Because the kidneys are constantly exposed to various fluoride concentrations, any health effects caused by fluoride would likely manifest themselves in kidney cells. However, several large community-based studies of people with long-term exposure to drinking water with fluoride concentrations up to 8 ppm have failed to show an increase in kidney disease.[166,253,295]

In a report issued in 1993 by the National Research Council, the Subcommittee on Health Effects of Ingested Fluoride stated that the threshold dose of fluoride in drinking water which causes kidney effects in animals is approximately 50 ppm - more than 12 times the maximum level allowed in drinking water by the Environmental Protection Agency. Therefore, they concluded that "ingestion of fluoride at currently recommended concentrations is not likely to produce kidney toxicity in humans."[167]

Many people with kidney failure depend on hemodialysis (treatment with an artificial kidney machine) for their survival. During hemodialysis, the patient's blood is exposed to large amounts of water each week (280-560 quarts). Therefore, procedures have been designed to ensure that the water utilized in the process contain a minimum of dissolved substances that could diffuse indiscriminately into the patient's bloodstream.[296] Since the composition of water varies in different geographic locations in the United States, the U.S. Public Health Service recommends dialysis units use techniques such as reverse osmosis and de-ionization to remove excess iron, magnesium, aluminum, calcium, and other minerals, as well as fluoride, from tap water before the water is used for dialysis.[296,297]

Additional information on this topic is available in Question 22.

QUESTION 41.

What are some of the erroneous health claims made against water fluoridation?

Answer:

From sources such as the Internet, newsletters, and personal anecdotes in e-mails, community water fluoridation is frequently charged with causing all of the following adverse health effects:

- AIDS
- Allergic Reactions (loss of hair, skin that burns and peels after contact with fluoridated water)
- Alzheimer's disease
- Arthritis
- Asthma
- Behavior Problems (attention deficit disorders)
- Bone Disease (osteoporosis –increased bone/hip fractures)
- Cancer (all types including osteosarcoma or bone cancer)
- Chronic Bronchitis
- Colic (acute abdominal pain)
- Down Syndrome
- Emphysema
- Enzyme Effects (gene-alterations)
- Flatulence (gas)
- Gastrointestinal Problems (irritable bowel syndrome)
- Harmful Interactions with Medications
- Heart Disease
- Increased Infant Mortality
- Kidney Disease
- Lead Poisonings
- Lethargy (lack of energy)
- Lower IQ (mental retardation)
- Malpositioned Teeth
- Pineal Gland (early puberty) (chronic insomnia)
- Reproductive Organs (damaged sperm) (reduced fertility)
- Skin Conditions (redness, rash/welts, itching)
- Sudden Infant Death Syndrome (SIDS)
- Thyroid Problems (goiter and obesity due to hypothroidism)

AND

- Tooth Decay

Fact.

As discussed throughout this booklet, the overwhelming weight of credible scientific evidence has consistently indicated that fluoridation of community water supplies is safe and effective. The possibility of any adverse health effects from continuous low-level consumption of fluoride has been and continues to be extensively studied. It has been determined that approximately 10% of dental fluorosis is attributable to water fluoridation. This type of very mild to mild fluorosis has been determined to be a cosmetic effect rather than an adverse health effect. Of the thousands of credible scientific studies on fluoridation, none has shown health problems associated with the consumption of optimally fluoridated water.

"Of the thousands of credible scientific studies on fluoridation, none has shown health problems associated with the consumption of optimally fluoridated water."

Notes

FLUORIDATION PRACTICE

QUESTION 42.

Will the addition of fluoride affect the quality of drinking water?

Answer.

Optimal levels of fluoride do not affect the quality of water. All ground and surface water in the United States contain some naturally occurring fluoride.

Fact.

Nearly all water supplies must undergo various water treatment processes to be safe and suitable for human consumption. During this process, more than 40 chemicals/additives are typically used including aluminum sulfate, ferric chloride, ferric sulfate, activated carbon, lime, soda ash and, of course, chlorine. Fluoride is added only to water that has naturally occurring levels lower than optimal.[36]

42.

43.

Fluoridation is the adjustment of the fluoride concentration of fluoride-deficient water supplies to the recommended range of 0.7 to 1.2 parts per million of fluoride for optimal dental health. The U.S. Environmental Protection Agency (EPA) recognizes that fluoride in children's drinking water at levels of approximately 1.0 ppm reduces the number of dental cavities.[298] The optimal level is dependent on the annual average of the maximum daily air temperature in a given geographic area.[36,55]

Additional information on this topic may be found in Questions 3 and 6.

Under the Safe Drinking Water Act, the EPA has established drinking water standards for a number of substances, including fluoride, in order to protect the public's health. There are several areas in the United States where the ground water contains higher than optimal levels of naturally occurring fluoride. Therefore, federal regulations were established to require that naturally occurring fluoride levels in a community water supply not exceed a concentration of 4.0 mg/L.[298] Under the Safe Drinking Water Act, this upper limit is the Maximum Contaminant Level (MCL) for fluoride. Under the MCL standard, if the naturally occurring level of fluoride in a public water supply exceeds the MCL (4.0 mg/L for fluoride), the water supplier is required to lower the level of fluoride below the MCL. This process is called defluoridation.

The EPA has also set a Secondary Maximum Contaminant Level (SMCL) of 2.0 mg/L, and requires consumer notification by the water supplier if the fluoride level exceeds 2.0 mg/L. The SMCL, while not federally enforceable, is intended to alert families that regular consumption of water with natural levels of fluoride greater than 2.0 mg/L by young children may cause moderate to severe dental fluorosis in the developing permanent teeth, a cosmetic condition with no known adverse health effect.[298] The notice to be used by water systems that exceed the SMCL must contain the following points:

1. The notice is intended to alert families that children under nine years of age who are exposed to levels of fluoride greater than 2.0 mg/liter may develop dental fluorosis.
2. Adults are not affected because dental fluorosis occurs only when developing teeth are exposed to elevated fluoride levels.
3. The water supplier can be contacted for information on alternative sources or treatments that will insure the drinking water would meet all standards (including the SMCL).

The 1993 National Research Council report, "Health Effects of Ingested Fluoride," reviewed fluoride toxicity and exposure data for the EPA and concluded that the current standard for fluoride at 4.0 mg/L (set in 1986) was appropriate as an interim standard to protect the public health.[167] In EPA's judgment, the combined weight of human and animal data support the current fluoride drinking water standard. In December 1993, the EPA published a notice in the *Federal Register* stating the ceiling of 4 mg/L would protect against adverse health effects with an adequate margin of safety and published a notice of intent not to revise the fluoride drinking water standards.[168]

The EPA further commented on the safety of fluoride in the December 5, 1997, *Federal Register*.[239] In a notice of a final rule relating to fluoride additives the EPA stated, "There exists no directly applicable scientific documentation of adverse medical effects at levels of fluoride below 8 mg/L (0.23mg/kg/day)." The EPA's Maximum Concentration Limit (MCL) of 4.0 mg/L (0.114 mg/kg/day) is one half that amount, providing an adequate margin of safety.

Under the Safe Drinking Water Act (SDWA), the EPA must periodically review the existing National Primary Drinking Water Regulations (NPDWRs) "not less often than every 6 years." This review is a routine part of the EPA's operations as dictated by the SDWA. NPDWRs, or primary standards, are legally enforceable standards that

apply to public water systems. Primary standards protect public health by limiting the levels of contaminants in drinking water.

In April 2002, the EPA announced the results of its preliminary revise/not revise decisions for 68 chemical NPDWRs. Fluoride was one of the 68 chemicals reviewed. The EPA determined that it fell under the "Not Appropriate for Revision at this Time" category, but noted that it planned to ask the National Academy of Science (NAS) to update the risk assessment for fluoride. The NAS had previously completed a review of fluoride for EPA approximately 12 years ago which was published as "Health Effects of Ingested Fluoride" in 1993 by the National Research Council.

At the request of the NAS, the National Research Council's Committee on Toxicology created the Subcommittee on Fluoride in Drinking Water to review toxicologic, epidemiologic, and clinical data published since 1993 and exposure data on orally ingested fluoride from drinking water and other sources (e.g., food, toothpaste, dental rinses). Based on this review the Subcommittee will evaluate the scientific and technical basis of the EPA's maximum contaminant level (MCL) of 4 milligram per liter (mg/L or ppm) and secondary maximum contaminant level (SMCL) of 2 mg/L for fluoride in drinking water and advise EPA on the adequacy of its fluoride MCL and SMCL to protect children and others from adverse health effects. Additionally, the Subcommittee will identify data gaps and make recommendations for future research relevant to setting the MCL and SMCL for fluoride.

The Subcommittee began its work in November 2002 and is currently projected to complete the project in early 2006.[173]

QUESTION 43.

Who regulates drinking water additives in United States?

Answer.

The United States Environmental Protection Agency regulates drinking water additives.

Fact

In 1974, Congress passed the original Safe Drinking Water Act (SDWA) which protects the public's health by regulating the nation's public drinking water supply.[299]

The SDWA, as amended in 1986 and 1996,[299] requires the U.S. Environmental Protection Agency (EPA) ensure the public is provided with safe drinking water.[155]

On June 22, 1979, the U.S. Food and Drug Administration (FDA) and the EPA entered into a Memorandum of Understanding (MOU) to clarify their roles and responsibilities in water quality assurance. The stated purpose of the MOU is to "avoid the possibility of overlapping jurisdiction between the EPA and FDA with respect to control of drinking water additives. The two agencies agreed that the SDWA's passage in 1974 implicitly repealed FDA's jurisdiction over drinking water as a 'food' under the Federal Food, Drug and Cosmetic Act (FFDCA). Under the agreement, EPA enjoys exclusive regulatory authority over drinking water served by public water supplies, including any additives in such water. FDA retains jurisdiction over bottled drinking water under Section 410 of the FFDCA and over water (and substances in water) used in food or food processing once it enters the food processing establishment."[155]

"From time to time, states and communities have had to deal with legislation or ballot initiatives aimed at requiring the approval of the FDA before any agent can be added to community water systems...On the surface, this may appear to be a 'common sense' approach. However, its only real purpose is to defeat efforts to provide water fluoridation. That is because it would require the FDA – which does NOT regulate water systems – to approve any water additive. By mistakenly (and perhaps craftily) naming the wrong federal agency, the probable outcome is to stop or prevent water fluoridation."

From time to time, states and communities have had to deal with legislation or ballot initiatives aimed at requiring the approval of the FDA before any agent can be added to community water systems. Often referred to as the Fluoride Product Quality Control Act, Water Product Quality Ordinance or Pure Water Ordinance, the legislation is specifically used by those opposed to water fluoridation as a tool to prevent water systems from providing community water fluoridation. Often this legislation does not mention fluoride or fluoridation. Those supporting this type of legislation may claim that they are not against water fluoridation but are proponents of pure water and do not want anything added to water that has not been approved by the FDA.

On the surface, this may appear to be a "common sense" approach. However, its only real purpose is to defeat efforts to provide water fluoridation. That is because it would require the FDA – which does NOT regulate water systems – to approve any water additive. By mistakenly (and perhaps craftily) naming the wrong federal agency, the probable outcome is to stop or prevent water fluoridation.

QUESTION 44.

What standards have been established to ensure the safety of fluoride additives used in community water fluoridation in the United States?

Answer.

The three fluoride additives used in the U.S. to fluoridate community water systems (sodium fluoride, sodium fluorosilicate, and fluorosilicic acid) meet safety standards established by the American Water Works Association (AWWA) and NSF International (NSF).

Fact.

Additives used in water treatment meet safety standards prepared in response to a request by the Environmental Protection Agency (EPA) to establish minimum requirements to ensure the safety of products added to water for its treatment, thereby ensuring the public's health. Specifically, fluoride additives used in water fluoridation meet standards established by the American Water Works Association (AWWA) and NSF International (NSF). Additionally, the American National Standards Institute (ANSI) endorses both AWWA and NSF standards for fluoridation additives and includes its name on these standards.

44.

The American Water Works Association is an international nonprofit scientific and educational society dedicated to the improvement of drinking water quality and supply. AWWA is the authoritative resource for knowledge, information, and advocacy to improve the quality and supply of drinking water in North America and beyond. Founded in 1881, AWWA is the largest organization of water supply professionals in the world.[300]

45.

NSF International, a not-for-profit, non-governmental organization, is the world leader in standards development, product certification, education, and risk-management for public health and safety. For 60 years, NSF has been committed to public health, safety, and protection of the environment. NSF is widely recognized for its scientific and technical expertise in the health and environmental sciences. Its professional staff includes engineers, chemists, toxicologists, and environmental health professionals with broad experience both in public and private organizations.[301]

46.

The American National Standards Institute (ANSI) is a private, non-profit organization that administers and coordinates the U.S. voluntary standardization and conformity assessment system. The Institute's mission is to enhance both the global competitiveness of U.S. business and the U.S. quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems, and safeguarding their integrity.[302]

The purpose of AWWA standards for fluoride additives is to provide purchasers, manufacturers and suppliers with the minimum requirements for fluoride additives, including physical, chemical, packaging, shipping and testing requirements. In part, the AWWA standards for fluoride additives state, "The [fluoride compound] supplied under this standard shall contain no soluble materials or organic substances in quantities capable of producing deleterious or injurious effects on the health of those consuming water that has been properly treated with the [fluoride compound]." Certified analyses of the additives must be furnished by the manufacturer or supplier.[60]

NSF Standard 60 ensures the purity of drinking water additives. NSF Standard 61 provides guidance for equipment used in water treatment plants. The NSF/ANSI Standards were developed by a consortium of associations including NSF, AWWA, the Association of State Drinking Water Administrators and the Conference of State Health and Environmental Managers with support from the EPA. In part, they establish minimum requirements for the control of potential adverse human health effects from products added to water for its treatment.[303,304]

Fluoride additives, like all of the more than 40 additives typically used in water treatment, are "industrial grade" additives. The water supply is an industry and all additives used at the water plant are classified as industrial grade additives. Examples of other "industrial grade" additives which are commonly used in water plant operations are chlorine (gas), ferrous sulfate, hydrochloric acid, sulfur dioxide and sulfuric acid.[36]

Sometimes antifluoridationists express the view that they are not really opposed to fluoridation, but are opposed to the use of "industrial grade" fluoride additives. They may even go so far as to state that they would support fluoridation if the process was implemented with pharmaceutical grade fluoride additives that were approved by the Food and Drug Administration (FDA). On the surface, this may appear to be a "common sense" approach. In fact, this is usually a ploy whose only real purpose is to stop fluoridation. The EPA, not the FDA, regulates additives in drinking water.

Additional information on this topic may be found in Question 43.

The claim is sometimes made that no studies on safety exist on the additives used in water fluoridation. The scientific community does not study health effects of concentrated additives as put into water; studies are done on the health effects of the treated water. While sodium fluoride was the first additive used in water fluoridation, the use of silicofluoride additives (sodium fluorosilicate and fluorosilicic acid) began in the late 1940s. By 1951, silicofluorides had become the most commonly used fluoride additives in water fluoridation.[61] Many of the early studies on the health effects of fluoridation were completed in communities that were using the silicofluoride additives, most generally fluorosilicic acid.[305-310] However, at that time, the additives used to fluoridate were not always identified in research reports. As the body of research on fluoridation grew, it became evident that there was no adverse health effects associated with water fluoridation regardless of which fluoride additive was used.

Additional information on this topic may be found in Question 5.

Additionally, over time, a number of comprehensive reviews of the health effects of fluoridation have been published. These reviews which support the safety of water fluoridation include many studies conducted in large fluoridated communities which used the silicofluoride additives.[71,84,163,165,167,311-313]

Beyond the foundation that has been established through the overwhelming weight of credible, peer-reviewed scientific evidence, there is over 60 years of practical experience that lends additional credence to the science that concludes that fluoridation is safe.

QUESTION 45.

What is the source of the additives used to fluoridate water supplies in the United States?

Answer.

Fluoride additives used in the United States are derived from the mineral apatite.

Fact.

The three fluoride additives used in the United States for water fluoridation (sodium fluoride, sodium fluorosilicate, and fluorosilicic acid) are derived from apatite which is a type of limestone deposit used in the production of phosphate fertilizers. Apatite contains 3-7% fluoride and is the main source of fluorides used in water fluoridation.[36]

During processing, apatite is ground up and treated with sulfuric acid, producing phosphoric acid (the main ingredient in the production of phosphate fertilizer) plus a solid and two gases. The solid, calcium sulfate (also known as gypsum) is the material used to form drywall or sheetrock. The two gases, hydrogen fluoride and silicon tetrafluoride, are captured in water to form fluorosilicic acid which today is the most commonly used fluoride additive in the United States.[60]

The two remaining fluoride additives (sodium fluoride and sodium fluorosilicate) are derived from fluorosilicic acid. Sodium fluoride is produced when fluorosilicic acid is neutralized with caustic soda. Fluorosilicic acid is neutralized with sodium chloride or sodium carbonate to produce sodium fluorosilicate.[36]

From time to time opponents of fluoridation allege that fluoridation additives are byproducts of the phosphate fertilizer industry in an effort to infer the additives are not safe. Byproducts are simply materials produced as a result of producing something else – they are by no means necessarily bad, harmful or waste products. In the chemical industry, a byproduct is anything other than the economically most important product produced. Byproducts may have certain characteristics which make them valuable resources. For example, in addition to orange juice, various byproducts are obtained from oranges during juice production that are used in cleaners, disinfectants, flavorings and fragrances.[314]

> "To ensure the public's safety, additives used in water fluoridation meet standards of the American Water Works Association (AWWA) and NSF International (NSF)."

Fluoride additives are valuable byproducts produced as a result of producing phosphate fertilizer. To ensure the public's safety, additives used in water fluoridation meet standards of the American Water Works Association (AWWA) and NSF International (NSF).

Additional information on this topic may be found in Question 44.

QUESTION 46.

Does the process of water fluoridation present unusual safety concerns for water systems and water operators?

Answer.

No. With proper planning, maintenance and monitoring, water fluoridation is a safe process.

Fact.

Water plant facilities and water plant personnel perform a valuable public service by carefully adjusting the level of fluoride in water to improve the oral health of the community. Facilities and personnel are subject to a number of regulations designed to ensure safety. The Occupational Safety and Health Administration (OSHA) provides guidelines for the safety of employees in the workplace.[60,315] Additionally, the American Water Works Association publishes detailed guidance on safety and safe working conditions for water plant personnel. Furthermore, the Centers for Disease Control and Prevention has established safety procedures designed specifically for water plant operators in charge of implementing fluoridation.[315] Adherence to these guidelines helps to ensure continuous levels of optimally fluoridated drinking water while maintaining water operator safety.

As part of the safety procedures, water plant personnel receive training on the management of the chemicals/additives in water plants. While the optimal fluoride concentration found in drinking water has been proven safe, water plant operators and engineers may be exposed to much higher fluoride levels when handling fluoride additives at the water treatment facility.[36] Fluoride additives present comparable risks as other chemicals/additives in common use at water treatment facilities, such as hypochloride, quick-lime, aluminum sulfate, sodium hydroxide and ferrous sulfate. In fact, the fluoride additives are much less dangerous than chlorine gas commonly used in water plant operations.

Today's equipment allows water treatment personnel to easily monitor and maintain the desired fluoride con-

centration. Automatic monitoring technology is available that can help to ensure that the fluoride concentration of the water remains within the recommended range.

It is important that the water treatment operators responsible for monitoring the addition of fluoride to the water supply be appropriately trained and that the equipment used for this process is adequately maintained.[315] As with any mechanical equipment, water fluoridation equipment should be tested, maintained and replaced as needed. With over 60 years of experience and thousands of water systems in operation, there have been remarkably few untoward incidents.

QUESTION 47.

Does fluoridation present difficult engineering problems?

Answer.

No. Properly maintained and monitored water fluoridation systems do not present difficult engineering problems.

Fact.

With proper planning and maintenance of the system, fluoride adjustment is compatible with other water treatment processes. Today's equipment allows water treatment personnel to easily monitor and maintain the desired fluoride concentration. Automatic monitoring technology is available that can help to ensure that the fluoride concentration of the water remains within the recommended range.

When added to community water supplies the concentrated fluoride additives become greatly diluted. For example, fluorosilicic acid is diluted approximately 180,000 times to reach the recommended range of 0.7 to 1.2 parts per million. At 1 ppm, one part of fluoride is diluted in a million parts of water. Large numbers such as a million can be difficult to visualize. While not exact, the following comparisons can be of assistance in comprehending one part per million:

1 inch in 16 miles
1 minute in 2 years
1 cent in $10,000

"Because there is more than 60 years of experience with water fluoridation, there is considerable guidance on sound engineering practices to design, construct, operate and maintain water fluoridation systems."

Because there is more than 60 years of experience with water fluoridation, there is considerable guidance on sound engineering practices to design, construct, operate and maintain water fluoridation systems. Fluoride additives are introduced to the water supply as liquids, but are measured by two basic types of devices, dry feeders or solution feeders (metering pumps). By design, and with proper maintenance and testing, water systems limit the amount of fluoride that can be added to the system (i.e., the use of a day tank that only holds one day's supply of fluoride) so prolonged over-fluoridation becomes a mechanical impossibility.[36]

QUESTION 48.

Will fluoridation corrode water pipes or add lead, arsenic and other toxic contaminants to the water supply?

Answer.

Allegations that fluoridation causes corrosion of water delivery systems are not supported by current scientific evidence.[36] Furthermore, the concentrations of contaminants in water as a result of fluoridation do not exceed, but, in fact, are well below regulatory standards set to ensure the public's safety.

Fact.

Water fluoridation has no impact on the acidity or pH of drinking water and will not cause lead and copper to be leached from water pipes. Corrosion of pipes by drinking water is related primarily to dissolved oxygen concentration, pH, water temperature, alkalinity, hardness, salt concentration, hydrogen sulfide content and the presence of certain bacteria. Under some water quality conditions, a small increase in the acidity of drinking water that is already slightly acidic may be observed after treatment with alum, chlorine, fluorosilicic acid or sodium florosilicate. In such cases, further water treatment is indicated by water plant personnel to adjust the pH upward to neutralize the acid. This is part of routine water plant operations. Note that the Water Quality Report or Consumer Confidence Report that all water systems send to customers on a yearly basis, lists the pH of the system's finished water and compares that level against the standard set at a pH of 7.0 (neutral) or higher indicating that the water leaving the plant is non-acidic.

Additional information on this topic may be found in Question 4.

A 1999 study[316] charged that fluorosilicic acid and sodium silicofluoride did not disassociate completely when added to water systems and may be responsible for lower pH levels of drinking water, leaching lead from plumbing systems and increasing lead uptake by children.

In response to the study, scientists from the U.S. Environmental Protection Agency (EPA) have reviewed the basic science that was the foundation for the claim that silicofluorides leach lead from water pipes and found that many of the chemical assumptions made in the original research were scientifically unjustified. Fluoride additives do disassociate very quickly and completely releasing fluoride ions into the water. The research was inconsistent with accepted scientific knowledge and the authors of the original studies failed to identify or account for these inconsistencies. The EPA scientists discounted

this study and said there was no credible data to suggest any link between fluoridation and lead.[285]

Fluorosilicic acid is the additive used to fluoridate the vast majority of community water systems in the U.S. Because it is a natural substance derived from apatite which is mined from the earth, fluorosilicic acid may contain minute amounts of contaminants such as lead and arsenic. However, existing regulations and standards require that these contaminants, including arsenic and lead, be at levels considered safe by the EPA when the fluorosilicic acid is diluted to produce optimally fluoridated water.[317,318] Evidence of testing by the fluoride additive manufacturer documents that the concentrations of these contaminants do not exceed, but, in fact, are well below regulatory standards set to ensure the public's safety. Most batches of the additive do not contain any detectable amount of either lead or arsenic. On average, the concentration of arsenic and lead in optimally fluoridated drinking water created using fluorosilicic acid is less than 0.1 part per billion.[319]

QUESTION 49.

Does fluoridated water harm the environment?

Answer.

Scientific evidence supports the fluoridation of public water supplies as safe for the environment and beneficial for people.

Fact.

The U.S. Environmental Protection Agency (EPA) has set an enforceable Federal drinking water standard for fluoride at 4.0 mg/L. As long as the 4.0 mg/L standard is not exceeded, State and local authorities determine whether or not to fluoridate.[320]

> *"Under the Washington's State Environmental Protection Act (SEPA), a study concluded that there are 'no probable significant adverse environmental impacts.'"*

Under the Washington's State Environmental Protection Act (SEPA), a study was conducted in Tacoma-Pierce County to investigate the environmental consequences of adding optimal levels of fluoride to drinking water. Noting that the amount of fluoride in the water does not reach levels that are harmful to plants or animals, the SEPA study concluded that there are "no probable significant adverse environmental impacts."[321]

There is no evidence that optimally fluoridated water has any effect on gardens, lawns or plants.[322]

A comprehensive literature review conducted in 1990 revealed absolutely no negative environmental impacts as a result of water fluoridation. Historically, issues surrounding problems with fluoride and the environment have involved incidents related to industrial pollution or accidents.[323]

Notes

PUBLIC POLICY

QUESTION 50.

Is water fluoridation a valuable public health measure?

Answer.

Yes. Water fluoridation is a public health measure that benefits people of all ages, is safe and is a community public health program that saves money.

Fact.

Throughout decades of research and more than 60 years of practical experience, fluoridation of public water supplies has been responsible for dramatically improving the public's oral health status. Former Surgeon General of the United States, Dr. Luther Terry, called fluoridation as vital a public health measure as immunization again disease, pasteurization of milk and purification of water.[7] Another former U.S. Surgeon General Dr. C. Everett Koop stated that fluoridation is the single most important commitment that a community can make to the oral health of its citizens.

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"Former U.S. Surgeon General Dr. C. Everett Koop stated that fluoridation is the single most important commitment that a community can make to the oral health of its citizens."

In 1994, the U.S. Department of Health and Human Services issued a report which reviewed public health achievements. Along with other successful public health measures such as the virtual eradication of polio and reductions in childhood blood lead levels, fluoridation was lauded as one of the most economical preventive values in the nation.[17] A policy statement on water fluoridation reaffirmed in 1995 by the U.S. Public Health Service (USPHS) stated that water fluoridation is the most cost-effective, practical and safe means for reducing the occurrence of dental decay in a community.[18] In 1998, recognizing the ongoing need to improve health and well being, the USPHS revised national health objectives to be achieved by the year 2010. Included under oral health was an objective to significantly expand the fluoridation of public water supplies. Specifically, Objective 21-9 states that at least 75% of the U.S. population served by community water systems should be receiving the benefits of optimally fluoridated water by the year 2010.[19]

"Former U.S. Surgeon General David Satcher, noted that water fluoridation is a powerful strategy in efforts to eliminate health disparities among populations."

In 1999, the Centers for Disease Control and Prevention named fluoridation of drinking water one of ten great public health achievements of the 20th century noting that it is a major factor responsible for the decline in dental decay.[1,2] Former U.S. Surgeon General David Satcher, issued the first ever Surgeon General report on oral health in May 2000. In *Oral Health in America: A Report of the Surgeon General*, Dr. Satcher stated that community water fluoridation continues to be the most cost-effective, practical and safe means for reducing and controlling the occurrence of dental decay in a community. Additionally, Dr. Satcher noted that water fluoridation is a powerful strategy in efforts to eliminate health disparities among populations. Studies have shown that fluoridation may be the most significant step we can take toward reducing the disparities in dental decay.[21-24] In the 2003 *National Call to Action to Promote Oral Health*, U.S. Surgeon General Richard Carmona called on policymakers, community leaders, private industry, health professionals, the media and the public to affirm that oral health is essential to general health and well being. Additionally, Surgeon General Carmona urged these groups to apply strategies to enhance the adoption and maintenance of proven community-based interventions such as community water fluoridation.[25]

Community water fluoridation is a most valuable public health measure because:

- Optimally fluoridated water is accessible to the entire community regardless of socioeconomic status, educational attainment or other social variables;[26]
- Individuals do not need to change their behavior to obtain the benefits of fluoridation.
- Frequent exposure to small amounts of fluoride over time makes fluoridation effective through the life span in helping to prevent dental decay.
- Community water fluoridation is more cost effective than other forms of fluoride treatments or applications.[27]

QUESTION 51.

Has the legality of water fluoridation been upheld by the courts?

Answer.

Yes. Fluoridation has been thoroughly tested in the United States' court system, and found to be a proper means of furthering public health and welfare. No court of last resort has ever determined fluoridation to be unlawful. Moreover, fluoridation has been clearly held not to be an unconstitutional invasion of religious freedom or other individual rights guaranteed by the First, Fifth or Fourteenth Amendments to the U.S. Constitution. And while cases decided primarily on procedural grounds have been won and lost by both pro and anti fluoridation interests, to ADA's knowledge no final ruling in any of those cases has found fluoridation to be anything but safe and effective.

"No court of last resort has ever determined fluoridation to be unlawful. The highest courts of more than a dozen states have confirmed the constitutionality of fluoridation."

Fact.

During the last sixty years, the legality of fluoridation in the United States has been thoroughly tested in our court systems. Fluoridation is viewed by the courts as a proper means of furthering public health and welfare.[324] No court of last resort has ever determined fluoridation to be unlawful. The highest courts of more than a dozen states have confirmed the constitutionality of fluoridation.[325] In 1984, the Illinois Supreme Court upheld the constitutionality of the state's mandatory fluoridation law, culminating 16 years of court action at a variety of judicial levels.[326] Moreover, the U.S. Supreme Court has denied review of fluoridation cases thirteen times, citing that no substantial federal or constitutional questions were involved.[325]

It has been the position of the American courts that a significant government interest in the health and welfare of the public generally overrides individual objections to public health regulation.[333] Consequently, the courts have rejected the contention that fluoridation ordinances are a deprivation of religious or individual freedoms guaranteed under the Constitution.[325,327] In reviewing the legal aspects of fluoridation, the courts have dealt with this concern by ruling that: (1) fluoride is a nutrient, not a medication, and is present naturally in the environment; (2) no one is forced to drink fluoridated water as alternative sources are available; and (3) in cases where a person believes that fluoridation interferes with religious beliefs, there is a difference between the freedom to believe, which is absolute, and the freedom to practice beliefs, which may be restricted in the public's interest.[328,329]

Fluoridation is the adjustment of a naturally occurring element found in water in order to prevent dental decay. Courts have consistently ruled that water fluoridation is not a form of compulsory mass medication or socialized medicine.[325,328,330] Fluoridation is simply the adjustment of a naturally occurring element found in water in order to prevent dental decay. In fact, water that has been fortified with fluoride is similar to fortifying salt with iodine, milk with vitamin D and orange juice with vitamin C – none of which are medications.

"To ADA's knowledge no final ruling in any of those cases has found fluoridation to be anything but safe and effective."

In recent years, challenges to fluoridation have been dismissed for a variety of reasons, including that plaintiffs admitted they could not establish injury by virtue of fluoridation, and that state law supporting fluoridation prevailed over local attempts to oppose fluoridation. Interestingly, pro and anti fluoridation interests have each won and lost legal challenges regarding which state or local agency has regulatory authority over fluoridation, which of course varies by state and locality. State law variances have also led to different rulings on other issues, such as whether downstream end users of fluoridation must be given an opportunity to vote on whether to fluoridate. While cases decided primarily on procedural grounds have been won and lost by both pro and anti fluoridation interests, to ADA's knowledge no final ruling in any of those cases has found fluoridation to be anything but safe and effective.

QUESTION 52.

Why does opposition to community water fluoridation continue?

Answer.

Fluoridation is considered beneficial by the overwhelming majority of the health and scientific communities as well as the general public. However, a small faction continues to speak out against fluoridation of municipal water supplies. Some individuals may view fluoridation of public water as limiting their freedom of choice; other opposition can stem from misinterpretations or inappropriate extrapolations of the science behind the fluoridation issue.

Fact.

A vast body of scientific literature endorses water fluoridation as a safe means of reducing the incidence of dental decay. Support for fluoridation among scientists and health professionals, including physicians and dentists, is nearly universal. Recognition of the benefits of

fluoridation by the American Dental Association, the American Medical Association, governmental agencies and other national health and civic organizations continues as a result of published, peer-reviewed research. (See Compendium at back of booklet.)

The majority of Americans also approves of water fluoridation. In June 1998, the Gallup Organization conducted a national survey of just over 1,000 adults on their attitudes toward community water fluoridation. When asked, "Do you believe community water should be fluoridated?", 70% answered *yes*, 18% answered *no* and 12% responded *don't know* (Figure 5). Results characterized by U.S. Census Region showed the level of support for community water fluoridation to be relatively constant throughout the United States, with 73% in the Northeast, 72% in the Midwest, 68% in the South and 70% in the West favoring community water fluoridation.[331] These results are consistent with a December 1991 Gallup survey that asked 1,200 parents, "Whether or not you presently have fluoridated water, do you approve or disapprove of fluoridating drinking water?" More than three-quarters (78%) of the responding parents approved, 10% disapproved and 12% answered don't know or refused to answer the question (Figure 6). Disapproval ranged from 4% in communities where water was fluoridated to 16% in communities where it was not.[332]

52.

Of the small faction that opposes water fluoridation for philosophical reasons, freedom of choice probably stands out as the most important single complaint.[333] Some individuals are opposed to community action on any health issue, others because of environmental or economic arguments and some because they are misinformed.

Opposition to fluoridation has existed since the initiation of the first community programs in 1945 and continues today with over 60 years of practical experience showing fluoridation to be safe and effective. An article that appeared in the local newspaper shortly after the first fluoridation program was implemented in Grand Rapids, Michigan, noted that the fluoridation program was slated to commence January 1 but did not actually begin until January 25. Interestingly, health officials in Grand Rapids began receiving complaints of physical ailments attributed to fluoridation from citizens weeks before fluoride was actually added to the water.[342]

Since that time, antifluoridation leaders and organizations have come and gone, but their basic beliefs have remained the same. These include: fluoride is toxic and causes numerous harmful health effects; fluoride does not prevent dental decay; fluoridation is costly; and fluoridation interferes with freedom of choice and infringes on individual rights.

While the arguments against fluoridation have remained relatively constant over the years, the antifluoridationists have used different approaches that play upon the popular concerns of the public at the time. For example, in the 1950s fluoridation was a Communist plot. With America's growing concern for environmental issues in the 1960s, fluoridation was pollution. After the Vietnam War in the 1970s, the antifluoridationists capitalized on the popularity of conspiracy theories by portraying fluoridation as a conspiracy between the U.S. government, the dental-medical establishment and industry. As Americans became more concerned about their health in the 1980s, antifluoridationists claimed fluoridation caused AIDS and Alzheimer's disease. In the 1990s, claims of hip fractures and cancer were designed to resonate with aging baby boomers. With the new millennium, overexposure and toxicity, in association with lead and arsenic poisoning, have surfaced as

Figure 5. 1998 Consumers' Opinions Regarding Community Water Fluoridation[331]

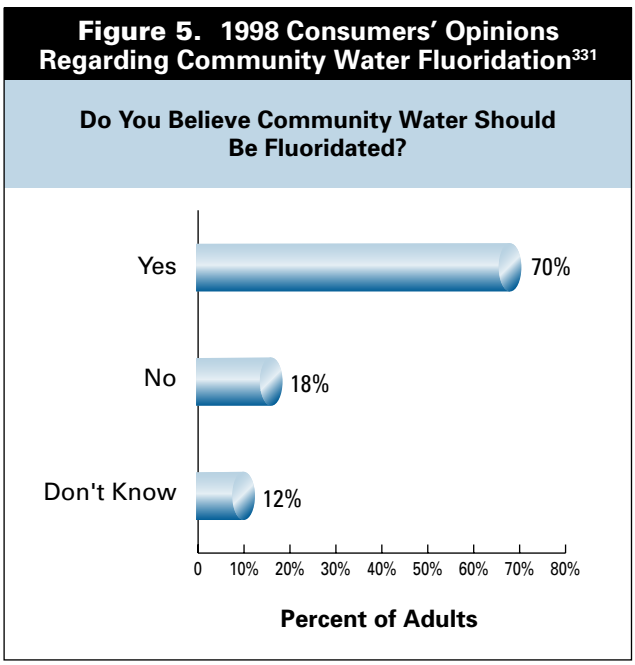
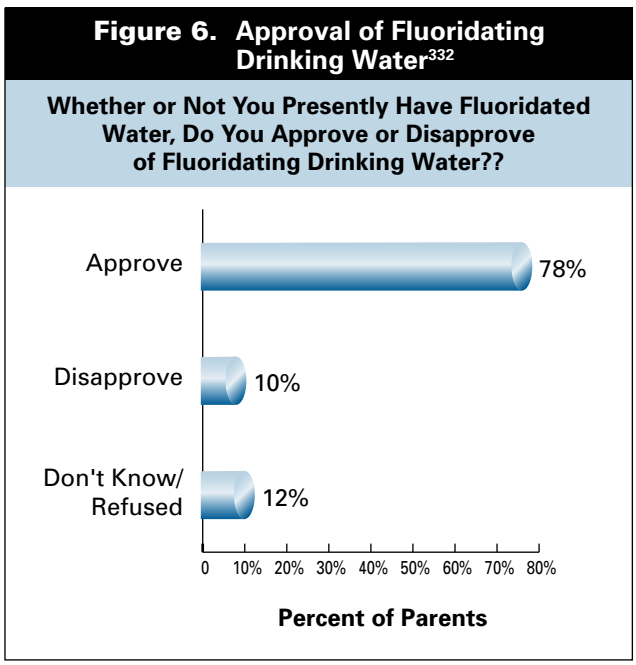


Figure 6. Approval of Fluoridating Drinking Water[332]



common themes. None of these approaches has ever really disappeared, but are often recycled as antifluoridationists choose which approach will have the most effect on the intended audience.[333]

Antifluoridationists have eagerly embraced technology such as videos and the Internet to spread their message to the public. These two venues have allowed the small faction of antifluoridationists to be linked across the country and around the world and promote their message economically.

A number of opposition videos are available from national antifluoridation organizations. These economically-priced videos make it affordable for every campaign to bring an antifluoridationist to the community via local cable access television. However, it has been the Internet that has breathed new life into the antifluoridation effort. The Internet has brought the antifluoridation message into voters' homes. With just a click of the mouse, search engines can locate hundreds of Web sites denouncing fluoridation, which may give the impression that this is a one-sided argument. Individuals who look to the Internet as a source of reliable information may fail to recognize that these sites often contain personal opinion rather than scientific fact. Newspaper stories, press releases and letters to the editor are often posted as documentation of the "science" behind antifluoridationists' claims. All too often, the public accepts this type of information as true simply because it is in print.

The techniques used by antifluoridationists are well known and have been discussed at length in a number of published articles that review the tactics used by antifluoridationists.[325,333,335-339] Examples of a few of the techniques can be viewed in Figure 7 on the next page.

"Reputable science is based on the scientific method of testing hypotheses in ways that can be reproduced and verified by others; junk science, which often provides too-simple answers to complex questions, often cannot be substantiated."

"Junk science," a term coined by the press and used over the past decade to characterize data derived from atypical or questionable scientific techniques, also can play a role in provoking opposition to water fluoridation. In fact, decision makers have been persuaded to postpone action on several cost-effective public health measures after hypothetical risks have made their way into the public media.[340] Junk science impacts public policy and costs society in immeasurable ways. More people, especially those involved in policy decisions, need to be able to distinguish junk science from legitimate scientific research. Reputable science is based on the scientific method of testing hypotheses in ways that can be reproduced and verified by others; junk science, which often provides too-simple answers to complex questions, often cannot be substantiated.

In 1993 the U.S. Supreme Court issued a landmark decision that many view as likely to restrict the use of junk science in the federal courts and in those state courts which adopt this reasoning. The Court determined that while "general acceptance" is not needed for scientific evidence to be admissible, federal trial judges have the task of ensuring that an expert's testimony rests on a reasonable foundation and is relevant to the issue in question. According to the Supreme Court, many considerations will bear on whether the expert's underlying reasoning or methodology is scientifically valid and applicable in a given case. The Court set out four criteria judges could use when evaluating scientific testimony:

(1) whether the expert's theory or technique can be (and has been) tested, using the scientific method,
(2) whether it has been subject to peer review and publication (although failing this criteria alone is not necessarily grounds for disallowing the testimony),
(3) its known or potential error rate and the existence and maintenance of standards in controlling its operation and
(4) whether it has attracted widespread acceptance within a relevant scientific community, since a known technique that has been able to attract only minimal support may properly be viewed with skepticism.

The scientific validity and relevance of claims made by opponents of fluoridation might be best viewed when measured against these criteria.[341]

"Opinions are seldom unanimous on any scientific subject. In fact, there may be no such thing as 'final knowledge,' since new information is continuously emerging and being disseminated. As such, the benefit evidence must be continually weighed against risk evidence. Health professionals, decision makers and the public should be cooperating partners in the quest for accountability where decisions are based on proven benefits measured against verified risks."

Opinions are seldom unanimous on any scientific subject. In fact, there may be no such thing as "final knowledge," since new information is continuously emerging and being disseminated. As such, the benefit evidence must be continually weighed against risk evidence. Health professionals, decision makers and the public should be cooperating partners in the quest for accountability where decisions are based on proven benefits measured against verified risks.[335]

Additional information on this topic may be found in the Introduction and Figure 1.

Figure 7. Opposition Tactics

Targeting Politicians and Community Leaders

Antifluoridation Web sites contain draft letters to be sent to newspaper publishers, water departments, and community public officials warning them of their "liability" should they support or endorse water fluoridation. Leaders are urged to remain "neutral" and allow fluoridation decisions to be put to a public vote therefore relieving the leaders of any and all responsibility in the matter. Antifluoridationists use the time gained to conduct a public referendum to bombard the public with misinformation designed to turn public opinion against fluoridation.

Unproven Claims

Antifluoridationists have repeatedly claimed fluoridation causes an entire laundry list of human illnesses including AIDS, Alzheimer's disease, cancer, Down Syndrome, genetic damage, heart disease, lower intelligence, kidney disease and osteoporosis (hip factures). These allegations are often repeated so frequently during campaigns that the public assumes they must be true. Their appearance in print, even if only in letters to the editor of the local newspaper, reinforces the allegation's credibility. With just a small amount of doubt established, the opposition slogan, "If in doubt, vote it out," may ring true with voters.

Innuendo

The statement, "Fifty years ago physicians and dentists posed for cigarette ads," is an example of innuendo or, more specifically, guilt by association. Even though fluoridation is not mentioned, individuals are expected to make the connection that the medical community changed its position on smoking so it is possible health professionals are wrong about fluoridation, too.

Outdated Studies and Statements from "Experts"

Antifluoridation Web sites often offer a list of "respected medical professionals and scientists" who have spoken out against fluoridation. One of those often quoted is Dr. Charles Gordon Heyd who is noted to be a Past President of the American Medical Association (AMA). What is not disclosed is the source of the quote or that Dr. Heyd was President of the AMA in 1936 – almost ten years before water fluoridation trials began. His decades-old quote certainly does not represent the current AMA position of support for water fluoridation and is characteristic of antifluoridationists' use of items that are out of date. Additionally, antifluoridationists have claimed that fourteen Nobel Prize winners have "opposed or expressed reservations about fluoridation." It should be noted that the vast majority of these individuals were awarded their prizes from 1929 through 1958.

Statements Out of Context

One of the most repeated antifluoridation statements is, "Fluoride is a toxic chemical. Don't let them put it in our water." This statement ignores the scientific principle that toxicity is related to dosage and not just to exposure to a substance. Examples of other substances that can be harmful in the wrong amounts but beneficial in the correct amounts are salt, vitamins A and D, iron, iodine, aspirin and even water itself.

In another example, a press release from the New York State Coalition Opposed to Fluoridation (NYSCOF) posted on the Internet in August 2001, and again in March 2005, stated, "Fluoridation is based more on unproven theories than scientific evidence, according to a revised dental textbook by leaders in the field." The press release also includes a number of items "quoted" from the textbook. The American Dental Association contacted the textbook authors who immediately wrote a letter responding to the press release. Drs. Brian A. Burt and Dr. Stephen A. Eklund responded, "The NYSCOF article takes a series of disconnected quotes from our textbook (Burt BA, Eklund SE. The Dentist, Dental Practice, and the Community 5th edition. Philadelphia: Saunders, 1999) and puts its own interpretation on them. The result is to portray Drs. Burt and Eklund as being opposed to fluoridation, which is most definitely not the case."

Moving Targets

In venues ranging from the media to the courts, opponents have been known to shift their theories of opposition frequently and mid-stream. This often appears to occur when one of their originally advanced points of opposition has been unveiled as being without merit. Some examples: A parent who told the media that he would need to move his family out of town because of past allergies to fluoride had to change his position after it was disclosed that the family had previously lived in a fluoridated community; and opponents filing repeated amendments to their legal complaints, in one case moving from an all out attack to the position that that they are not opposed to fluoridation, but just to one particular chemical - without telling the court that the chemical has been safely and extensively used for decades.

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QUESTION 53.

Where can reliable information about water fluoridation be found on the Internet and World Wide Web?

Answer.

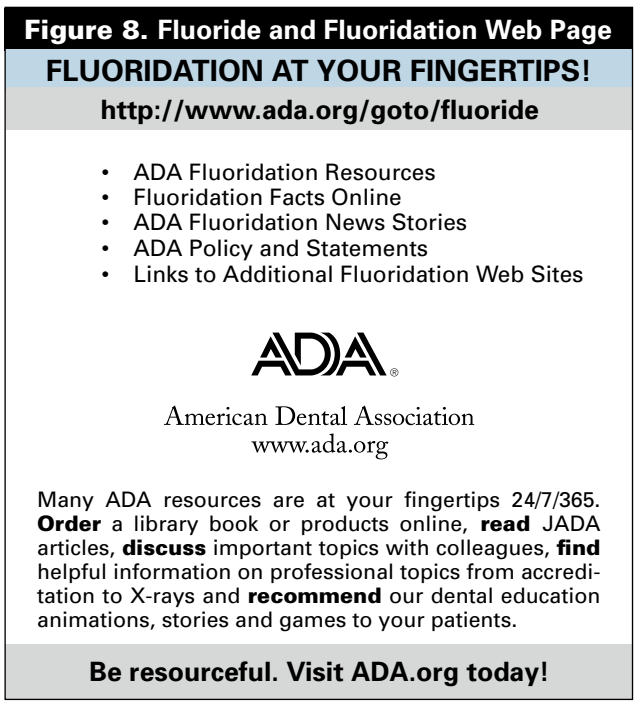
The American Dental Association, as well as other reputable health and science organizations, and government agencies have sites on the Internet/Web that provide information on fluorides and fluoridation. These sites provide information that is consistent with generally accepted scientific knowledge.

Fact.

The Internet and World Wide Web are evolving as accessible sources of information. However, not all "science" posted on the Internet and World Wide Web is based on scientific fact. Searching the Internet for "fluoride" or "water fluoridation" directs individuals to a number of Web sites. Some of the content found in the sites is scientifically sound. Other less scientific sites may look highly technical, but contain information based on science that is unconfirmed or has not gained widespread acceptance. Commercial interests, such as the sale of water filters, may also be promoted.

One of the most widely respected sources for information regarding fluoridation and fluorides is the American Dental Association's (ADA) Fluoride and Fluoridation Web site at http:www.ada.org/goto/fluoride (Figure 8). From the ADA Web site individuals can link to other Web sites, such as the Centers for Disease Control and Prevention, National Institute of Dental and Craniofacial Research, Institute of Medicine, National Cancer Institute, and state/local health departments for more information about fluoride and water fluoridation.

Figure 8. Fluoride and Fluoridation Web Page



QUESTION 54.

Why does community water fluoridation sometimes lose when it is put to a public vote?

Answer.

Voter apathy or low voter turnout due the vote being held as a special election or in an "off" year, confusing ballot language (a "no" vote translates to support for fluoridation), blurring of scientific issues, lack of leadership by elected officials and a lack of political campaign skills among health professionals are some of the reasons fluoridation votes are sometimes unsuccessful.

Fact.

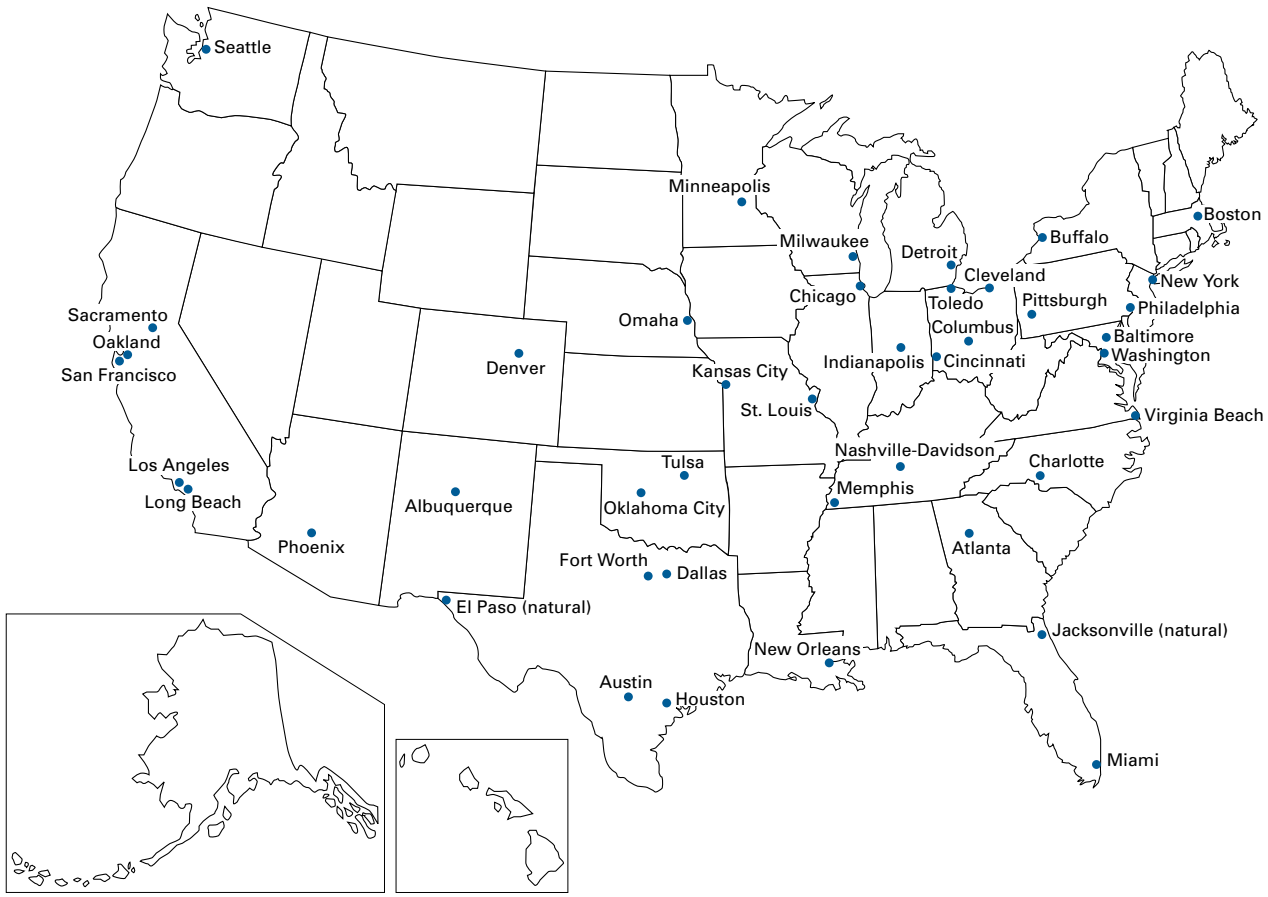
Despite the continuing growth of fluoridation in this country over the past decades, millions of Americans do not yet receive the protective benefits of fluoride in their drinking water. Centers for Disease Control and Prevention (CDC) data from 2002 indicate, only two-thirds (67.3%) of the population served by public water systems have access to fluoridated water.[34] Forty-two of the 50 largest cities are fluoridated by adjustment. Another two have natural optimal levels of fluoridation (Figure 9). The remaining six nonfluoridated cities are: Fresno, California; San Jose, California; Colorado Springs, Colorado; Honolulu, Hawaii; Wichita, Kansas and Portland, Oregon. In 1998, recognizing the ongoing need to improve health and well being, the U.S. Public Health Service revised national health objectives to be achieved by the year 2010. Included under oral health was an objective to significantly expand the fluoridation of public water supplies. Specifically, Objective 21-9 states that at least 75% of the U.S. population served by community water systems should be receiving the benefits of optimally fluoridated water by the year 2010.[19] Although water fluoridation reaches some residents in every state, 2002 data indicates that only 24 states are providing these benefits to 75% or more of their residents.[34] (Figure 10).

Social scientists have conducted studies to examine why fluoridation fails when put to a public vote. Among the factors noted are lack of funding, public and professional apathy, the failure of many legislators and community leaders to take a stand because of perceived controversy, low voter turnout and the difficulty faced by an electorate in evaluating scientific information in the midst of emotional charges by opponents. Unfortunately, citizens may mistakenly believe their water contains optimal levels of fluoride when, in fact, it does not.

"Clever use of emotionally charged 'scare' propaganda by fluoride opponents creates fear, confusion and doubt within a community when voters consider the use of fluoridation."

Figure 9. Forty-Two of the Fifty Largest Cities in the U.S. are Supplied with Fluoridated Water*

Two cities (Jacksonville, Florida and El Paso, Texas) are naturally fluoridated.



*Data compiled by the American Dental Association and Centers for Disease Control and Prevention/Division of Oral Health. Information current as of May 2005.

Clever use of emotionally charged "scare" propaganda by fluoride opponents creates fear, confusion and doubt within a community when voters consider the use of fluoridation.[342,343] Defeats of referenda or the discontinuance of fluoridation have occurred most often when a small, vocal and well organized group has used a barrage of fear-inspiring allegations designed to confuse the electorate. In addition to attempts to influence voters, opponents have also threatened community leaders with personal litigation.[344] While no court of last resort has ever ruled against fluoridation, community leaders may be swayed by the threat of litigation due to the cost and time involved in defending even a groundless suit, not to mention threats of political fallout. The American Dental Association (ADA) knows of no cases in which community leaders have been found liable for their pro-fluoridation efforts. In no instance has fluoridation been discontinued because it was proven harmful in any way.[343-345]

Adoption of fluoridation is ultimately a decision of state or local decision makers, whether determined by elected officials, health officers or the voting public. Fluoridation can be enacted through state legislation, administrative regulation or a public referendum. While fluoridation is not legislated at the federal level, it is legislated at the state and local level. As with any pubic health measure, a community has the right and obligation to protect the health and welfare of its citizens, even if it means overriding individual objections to implement fluoridation.

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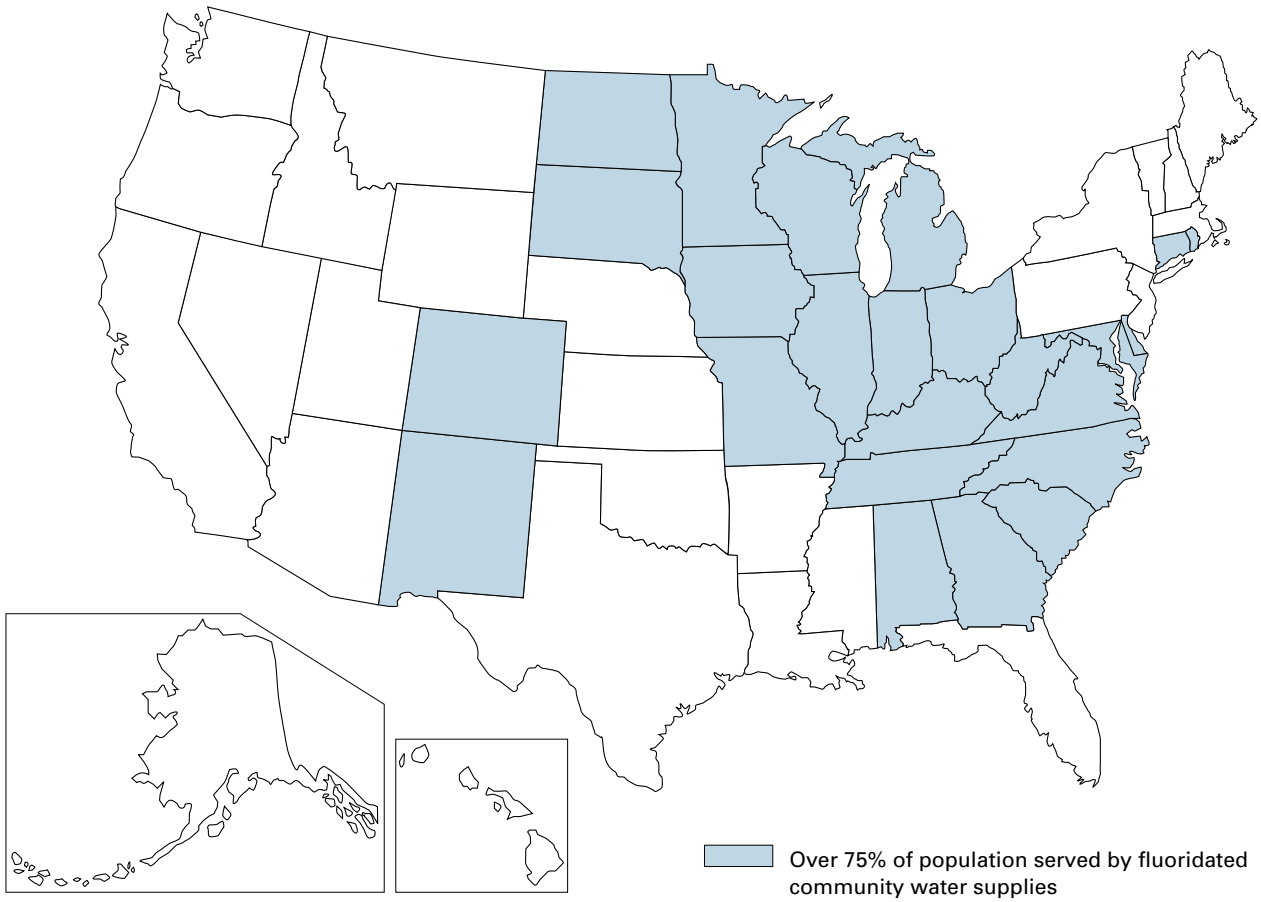
Figure 10. State Fluoridation Status

States Meeting the Healthy People 2010 Goal of 75% of the Population Served by Fluoridated Community Water Supplies*



*Data Source: Centers for Disease Control and Prevention/Division of Oral Health. "Percentage of U.S. Population on Public Water Supply Systems Receiving Fluoridated Water" 2002. Available at http://www2.cdc.gov/nohss/FluoridationV.asp.

"In the past five years (2000 through 2004), more than 125 communities in 36 states have decided to provide the benefits of fluoridation for their residents."

Each spring as part of the yearly Community Water Fluoridation Awards program, the ADA, Association of State and Territorial Dental Directors and the CDC Division of Oral Health compile a list of water systems/communities in the United States that have adopted community water fluoridation in the past year. This list is posted on the ADA Web site at http://www.ada.org/goto/fluoride. In the past five years (2000 through 2004), more than 125 communities in 36 states have decided to provide the benefits of fluoridation for their residents. The size of these water systems/communities varies greatly – from those with a few thousand residents to the Metropolitan Water District of Southern California which will provide fluoridated water to more than 18 million people.

Technical assistance with fluoridation efforts is available from the Council on Access, Prevention and Interprofessional Relations at the ADA. Additional support for fluoridation is available from ADA's Division of Legal Affairs, Division of Communications and Department of State Government Affairs.

QUESTION 55.

Is community water fluoridation accepted by other countries?

Answer.

Over 405 million people in more than 60 countries worldwide enjoy the benefits of fluoridated water.[132]

"The value of water fluoridation is recognized internationally...Considering the extent to which fluoridation has already been implemented throughout the world, the lack of documentation of adverse health effects is remarkable testimony to its safety."

Fact.

The value of water fluoridation is recognized internationally. Countries and geographic regions with extensive water fluoridation include the U.S., Australia, Brazil, Canada, Chile, Columbia, Ireland, Israel, Malaysia, New Zealand, People's Republic of China (Hong Kong only), Singapore and the United Kingdom.[132] Thorough investigations of fluoridation have been conducted in Britain and Australia supporting the safety and effectiveness of water fluoridation.[163,165,346] Considering the extent to which fluoridation has already been implemented throughout the world, the lack of documentation of adverse health effects is remarkable testimony to its safety.[84,163-167,210] The World Health Organization (WHO) and the Pan American Health Organization have endorsed the practice of water fluoridation since 1964. In 1994, an expert committee of WHO published a report which reaffirmed its support of fluoridation as being safe and effective in the prevention of dental decay, and stated that "provided a community has a piped water supply, water fluoridation is the most effective method of reaching the whole population, so that all social classes benefit without the need for active participation on the part of individuals."[138] In many parts of the world, fluoridation is not feasible or a high priority, usually due to the lack of a central water supply, the existence of more life threatening health needs or the lack of trained technical personnel or sufficient funds for start-up and maintenance costs.

QUESTION 56.

Is community water fluoridation banned in Europe?

Answer.

No country in Europe has banned community water fluoridation.

Fact.

The claim that fluoridation is banned in Europe is frequently used by fluoridation opponents. In truth, European countries construct their own water quality regulations within the framework of the 1980 European Water Quality Directive. The Directive provides maximum admissible concentrations for many substances, one of which is fluoride. The Directive does not require or prohibit fluoridation, it merely requires that the fluoride concentration in water does not exceed the maximum permissible concentration.[347]

Many fluoridation systems that used to operate in Eastern and Central Europe did not function properly and, when the Iron Curtain fell in 1989-90, shut down because of obsolete technical equipment and lack of knowledge as to the benefits of fluoridated water.[348] Water fluoridation is not practical in some European countries because of complex water systems with numerous water sources. As an alternative to water fluoridation, many European countries have opted for the use of fluoride supplements or salt fluoridation.

Basel, Switzerland is one such example. Those opposed to water fluoridation claimed a large victory when Basel voted to cease water fluoridation in 2003. The facts are that Basel was the lone city with fluoridated water surrounded by communities that used fluoridated salt. In the mid 90s, trade barriers that had prevented fluoridated salt from being sold to those living in Basel fell and soon it was evident that residents were receiving fluoride from salt as well as through drinking water. The government voted to cease water fluoridation in 2003 in light of availability and use of fluoridated salt in the community. Basel, Switzerland did not stop fluoridating. Officials simply chose another type of fluoridation – salt fluoridation.[349]

Additional information on this topic may be found in Question 14.

"No European country has imposed a 'ban' on water fluoridation."

Again, no European country has imposed a "ban" on water fluoridation, it has simply not been implemented for a variety of technical, legal, financial or political reasons.

Political actions contrary to the recommendations of health authorities should not be interpreted as a negative response to water fluoridation. For example, although fluoridation is not carried out in Sweden and the Netherlands, both countries support World Health Organization's recommendations regarding fluoridation as a preventive health measure, in addition to the use of fluoride toothpastes, mouthrinses and dietary fluoride supplements.[138,350]

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Notes

COST EFFECTIVENESS

QUESTION 57.

Is water fluoridation a cost-effective means of preventing tooth decay?

Answer.

Yes. Fluoridation has substantial lifelong decay preventive effects and is a highly cost-effective means of preventing tooth decay in the United States, regardless of socioeconomic status.[97,103,104,351-353]

Fact.

The cost of community water fluoridation can vary in each community depending on the following factors.[354]

1. Size of the community (population and water usage);
2. Number of fluoride injection points where fluoride additives will be added to the water system;
3. Amount and type of equipment used to add and monitor fluoride additives;
4. Amount and type of fluoride compound used, its price, and its costs of transportation and storage; and
5. Expertise of personnel at the water plant.

The annual cost for a U.S. community to fluoridate its water is estimated to range from approximately $0.50 per person in large communities to approximately $3.00 per person in small communities.[355]

57.

58.

> *"For most cities, every $1 invested in water fluoridation saves $38 in dental treatment costs."*

It can be calculated from these data that the average lifetime cost per person to fluoridate a water system is less than the cost of one dental filling. When it comes to the cost of treating dental disease, everyone pays. Not just those who need treatment, but the entire community-through higher health insurance premiums and higher taxes. For most cities, every $1 invested in water fluoridation saves $38 in dental treatment costs.[355] Cutting dental care costs by decreasing dental decay is something a community can do to improve oral health and save money for everyone. With the escalating cost of health care, fluoridation remains a preventive measure that benefits members of the community at minimal cost.[25] Fluoridation is a community public health measures that saves money.

School-based dental disease prevention activities (such as fluoride mouthrinse or tablet programs), professionally applied topical fluorides and dental health education are beneficial but have not been found to be as cost-effective in preventing dental decay as community water fluoridation.[351] Fluoridation remains the most cost-effective and practical form of preventing decay in the United States and other countries with established municipal water systems.[17,97,104,355]

Because of the decay-reducing effects of fluoride, the need for restorative dental care is typically lower in fluoridated communities. Therefore, an individual residing in a fluoridated community will typically have fewer restorative dental expenditures during a lifetime. Health economists at a 1989 workshop concluded that fluoridation costs approximately $3.35 per tooth surface when decay is prevented, making fluoridation "one of the very few public health procedures that actually saves more money than it costs."[355] Considering the fact that the national average fee for a two surface amalgam (silver) restoration in a permanent tooth placed by a general dentist is $101.94*, fluoridation clearly demonstrates significant cost savings.[356]

In a study conducted in Louisiana, Medicaid-eligible children (ages 1-5) residing in communities without fluoridated water were three times more likely than Medicaid-eligible children residing in communities with fluoridated water to receive dental treatment in a hospital and the cost of dental treatment per eligible child was approximately twice as high. In addition to community water fluoridation status, the study took into account per capita income, population and number of dentists per county.[358]

> *"The economic importance of fluoridation is underscored by the fact that frequently the cost of treating dental disease is paid not only by the affected individual, but also by the general public through services provided by health departments, community health clinics, health insurance premiums, the military and other publicly supported medical programs."*

The economic importance of fluoridation is underscored by the fact that frequently the cost of treating dental disease is paid not only by the affected individual, but also by the general public through services provided by health departments, community health clinics, health insurance premiums, the military and other publicly supported medical programs.[103]

Indirect benefits from the prevention of dental decay may include:

- freedom from dental pain
- a more positive self image
- fewer missing teeth
- fewer cases of malocclusion aggravated by tooth loss
- fewer teeth requiring root canal treatment
- reduced need for dentures, bridges and implants
- less time lost from school or work because of dental pain or visits to the dentist

These intangible benefits are difficult to measure economically, but are extremely important.[97,257]

*The survey data should not be interpreted as constituting a fee schedule in any way, and should not be used for that purpose. Dentists must establish their own fees based on their individual practice and market considerations.

QUESTION 58.

Why fluoridate an entire water system when the vast majority of the water is not used for drinking?

Answer.

It is more practical to fluoridate an entire water supply than to attempt to treat individual water sources.

Fact.

It is technically difficult, perhaps impossible, and certainly more costly to fluoridate only the water used for drinking. Community water that is chlorinated, softened, or in other ways treated is also used for watering lawns, washing cars and for most industrial purposes. The cost of additives for fluoridating a community's water supply is inexpensive on a per capita basis; therefore, it is practical to fluoridate the entire water supply.

Fluoride is but one of more than 40 different chemicals/additives that may be used to treat water in the United States. Most are added for aesthetic or convenience purposes such as to improve the odor or taste, prevent natural cloudiness or prevent staining of clothes or porcelain.[36]

The American Water Works Association, an international nonprofit scientific and educational society dedicated to the improvement of drinking water quality and supply, supports the practice of fluoridation of public water supplies.[357]

Additional information on this topic may be found in Question 44.

CALL TO ACTION

In April 2003, Surgeon General Richard H. Carmona issued a National Call to Action to Promote Oral Health. The report was a wake-up call, raising a powerful voice against the silence. It called upon policymakers, community leaders, private industry, health professionals, the media, and the public to affirm that oral health is essential to general health and well-being and to take action.

While the effectiveness of preventive interventions such as community water fluoridation have been persuasively demonstrated, less than half of the fifty states have implemented fluoridation at the level to meet the national health objectives to be achieved by the year 2010. Specifically, Objective 21-9 states that at least 75% of the U.S. population served by community water systems should be receiving the benefits of optimally fluoridated water by the year 2010.

Fluoridation efforts at the local and state level can be greatly enhanced and the U.S. Healthy People 2010 Objective reached with the efforts of organizations, agencies and individuals who share a communication to the benefits of community water fluoridation.

Technical assistance with fluoridation efforts is available from the Council on Access, Prevention and Interprofessional Relations at ADA. Additional support for fluoridation is available from ADA's Division of Legal Affairs, Division of Communications and Department of State Government Affairs.

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Statements from Five Leading Health Organizations Regarding Community Water Fluoridation

AMERICAN DENTAL ASSOCIATION (ADA)

"The Association endorses community water fluoridation as a safe, beneficial and cost-effective public health measure for preventing dental caries. This support has been the Association's policy since 1950."

— ADA Operational Policies and Recommendations Regarding Community Water Fluoridation (Trans.1997:673).

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

"During the 20th century, the health and life expectancy of persons residing in the United States improved dramatically. To highlight these advances, MMWR will profile 10 public health achievements in a series of reports published through December 1999 (Fluoridation of drinking water was chosen as one of these achievements and profiled in the October 22, 1999 MMWR). Fluoridation safely and inexpensively benefits both children and adults by effectively preventing tooth decay, regardless of socioeconomic status or access to care. Fluoridation has played an important role in the reductions in tooth decay (40%-70% in children) and of tooth loss in adults (40%-60%)."

— CDC, Morbidity and Mortality Weekly Report. "Ten Great Public Health Achievements-United States 1900-1999" April 1999.

AMERICAN MEDICAL ASSOCIATION (AMA)

"The AMA recognizes the important public health benefits of drinking properly fluoridated water and encourages its member physicians and medical societies to work with local and state health departments, dental societies, and concerned citizens to assure the optimal fluoridation of community drinking water supplies."

— AMA Letter to the American Dental Association, March 10, 1995.

U.S. SURGEON GENERAL

"A significant advantage of water fluoridation is that all residents of a community can enjoy its protective benefit – at home, work, school or play – simply by drinking fluoridated water or beverages and foods prepared with it…Water fluoridation is a powerful strategy in our efforts to eliminate differences in health among people and is consistent with my emphasis on the importance of prevention…Fluoridation is the single most effective public health measure to prevent tooth decay and improve oral health over a lifetime, for both children and adults.

While we can be pleased with what has already been accomplished, it is clear that there is much yet to be done. Policymakers, community leaders, private industry, health professionals, the media, and the public should affirm that oral health is essential to general health and well being and *take action to make ourselves, our families, and our communities healthier. I join previous Surgeons General in acknowledging the continuing public health role for community water fluoridation in enhancing the oral health of all Americans."*

— Surgeon General Richard H. Carmona, Statement on Community Water Fluoridation, July 28, 2004.

NATIONAL INSTITUTE OF DENTAL & CRANIOFACIAL RESEARCH (NIDCR)

"The National Institute of Dental and Craniofacial Research continues to support water fluoridation as a safe and effective method of preventing tooth decay in people of all ages. Community water fluoridation is a public health effort that benefits millions of Americans. For more than half a century, water fluoridation has helped improve the quality of life in the U.S. through reduced pain and suffering related to tooth decay, reduced tooth loss, reduced time lost from school and work, and less money spent on dental care."

— NIDCR: Statement on Water Fluoridation, June 2000.

COMPENDIUM

National and International Organizations That Recognize the Public Health Benefits of Community Water Fluoridation for Preventing Dental Decay

Academy of Dentistry International
Academy of General Dentistry
Academy for Sports Dentistry
Alzheimer's Association
America's Health Insurance Plans
American Academy of Family Physicians
American Academy of Nurse Practitioners
American Academy of Oral and Maxillofacial Pathology
American Academy of Orthopaedic Surgeons
American Academy of Pediatrics
American Academy of Pediatric Dentistry
American Academy of Periodontology
American Academy of Physician Assistants
American Association for Community Dental Programs
American Association for Dental Research
American Association for Health Education
American Association for the Advancement of Science
American Association of Endodontists
American Association of Oral and Maxillofacial Surgeons
American Association of Orthodontists
American Association of Public Health Dentistry
American Association of Women Dentists
American Cancer Society
American College of Dentists
American College of Physicians–American Society of Internal Medicine
American College of Preventive Medicine
American College of Prosthodontists
American Council on Science and Health
American Dental Assistants Association
American Dental Association
American Dental Education Association
American Dental Hygienists' Association
American Dietetic Association
American Federation of Labor and Congress of Industrial Organizations
American Hospital Association
American Legislative Exchange Council
American Medical Association
American Nurses Association
American Osteopathic Association
American Pharmacists Association
American Public Health Association
American School Health Association
American Society for Clinical Nutrition
American Society for Nutritional Sciences
American Student Dental Association
American Veterinary Medical Association
American Water Works Association
Association for Academic Health Centers
Association of American Medical Colleges
Association of Clinicians for the Underserved
Association of Maternal and Child Health Programs
Association of State and Territorial Dental Directors
Association of State and Territorial Health Officials
Association of State and Territorial Public Health Nutrition Directors
British Fluoridation Society
Canadian Dental Association
Canadian Dental Hygienists Association
Canadian Medical Association
Canadian Nurses Association
Canadian Paediatric Society
Canadian Public Health Association
Child Welfare League of America
Children's Dental Health Project
Chocolate Manufacturers Association
Consumer Federation of America
Council of State and Territorial Epidemiologists
Delta Dental Plans Association
FDI World Dental Federation
Federation of American Hospitals
Hispanic Dental Association
Indian Dental Association (U.S.A.)
Institute of Medicine
International Association for Dental Research
International Association for Orthodontics
International College of Dentists
March of Dimes Birth Defects Foundation
National Association of Community Health Centers
National Association of County and City Health Officials
National Association of Dental Assistants
National Association of Local Boards of Health
National Association of Social Workers
National Confectioners Association
National Council Against Health Fraud
National Dental Assistants Association
National Dental Association
National Dental Hygienists' Association
National Down Syndrome Congress
National Down Syndrome Society
National Eating Disorders Association
National Foundation of Dentistry for the Handicapped
National Head Start Association
National Health Law Program
National Healthy Mothers, Healthy Babies Coalition
Oral Health America
Robert Wood Johnson Foundation
Society for Public Health Education
Society of American Indian Dentists
Special Care Dentistry
  Academy of Dentistry for Persons with Disabilities
  American Association of Hospital Dentists
  American Society for Geriatric Dentistry
The Children's Health Fund
The Dental Health Foundation (of California)
U.S. Department of Defense
U.S. Department of Veterans Affairs
U.S. Public Health Service
  Centers for Disease Control and Prevention (CDC)
  National Institute of Dental and Craniofacial Research (NIDCR)
World Federation of Orthodontists

The list above was current at the time Fluoridation Facts went to press. As organizations and entities continue to be added to the Compendium, the most current Compendium can be viewed on ADA.org at http://www.ada.org/goto/ffcompendium.

American Dental Association
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