International Academy of Oral Medicine and Toxicology (IAOMT) Comprehensive Review on Artificial Water Fluoridation

David Kennedy, DDS, MIAOMT
Amanda Just, MS, Program Director of the IAOMT
John Kall, DMD, FAGD, MIAOMT
Griffin Cole, DDS, NMD, MIAOMT

Originally Released on September 22, 2017

This document consists of excerpts taken from the document entitled "International Academy of Oral Medicine and Toxicology (IAOMT) Position Paper against Fluoride Use in Water, Dental Materials, and Other Products for Dental and Medical Practitioners, Dental and Medical Students, Consumers, and Policy Makers."

Click here to access the full document.

TABLE OF CONTENTS

Section 1: Chemical Profile and Examples of Products with Added Fluoride

Fluorine (F) is the ninth element on the periodic table and is a member of the halogen family. *Fluoride* (F-) is a chemical ion of fluorine that contains an extra electron, thereby giving it a negative charge. Other than its natural existence in minerals, as well as in soil, water, and air, fluoride is also chemically synthesized for use in community water fluoridation, dental products, and other manufactured items, as shown in Table 1.

Table 1: Examples of Products that May Contain Added Fluoride

Artificially fluoridated municipal water	Beverages (made with fluoridated water)
Dental cements with fluoride	Dental fillings with fluoride
Dental gels with fluoride	Dental varnishes with fluoride
Floss with fluoride	Fluoride drugs ("supplements")
Food (that contains or has been exposed to fluoride)	Mouthwash with fluoride
Pesticides with fluoride	Pharmaceutical drugs with perfluorinated compounds
Stain resistant and waterproof items with PFCs	Toothpaste with fluoride

Fluoride is not essential for human growth and development.[1] In fact, it is not required for any physiological process in the human body; consequently, no one will suffer from a lack fluoride. In 2014, Dr. Philippe Grandjean of the Harvard School of Public Health and Dr. Philip J. Landrigan of Icahn School of Medicine at Mount Sinai identified fluoride as one of 12 industrial chemicals known to cause developmental neurotoxicity in humans.[2]

Section 2: Sources of Fluoride in Water

Fluoride exposure in humans occurs from in water from both natural and anthropogenic sources. Natural fluoride in water occurs when water run-off is exposed to fluoride containing rock. Because of this geological factor, different regions have higher or lower levels of natural fluoride in water. Additional fluoride in water occurs due to human activity through community water fluoridation, as well as through industrial emissions, such as releases from coal-fired power plants.

Most of the fluoride added to drinking water is in the form of fluorosilicates, also known as fluosilicic acid (fluorosilicic acid, H_2SiF_6) and sodium salt (sodium fluorosilicate, Na_2SiF_6).[3] Although fluoride is added to some bottled water, *this comprehensive review focuses only on artificial water fluoridation*.

Section 3: Brief History of Artificial Water Fluoridation

Human knowledge of the mineral fluorspar dates back centuries.[4] However, the discovery of how to isolate fluorine from its compounds is an essential date in the history of humankind's use of fluoride: Several scientists were killed in early experiments involving attempts to generate elemental fluorine, but in 1886, Henri Moissan reported the isolation of elemental fluorine, which earned him the Nobel Prize in chemistry in 1906.[5] [6]

This discovery paved the way for human experimentation to begin with chemically synthesized fluorine compounds, which were eventually utilized in a number of industrial activities. Notably, uranium fluoride and thorium fluoride were used during the years of 1942-1945 as part of the Manhattan Project[7] to produce the first atomic bomb. Data from reports about the Manhattan Project, some of which were initially classified and unpublished, include mention of fluoride poisoning and its role in the hazards of the uranium industry.[8] As industry expanded during the 20th century, so did the use of fluoride for industrial processes, and cases of fluoride poisoning likewise increased.[9]

Fluoride was not widely used for any dental purposes prior to the mid-1940's,[10] although it was studied for dental effects caused by its natural presence in community water supplies at varying levels. Early research in the 1930's by Frederick S. McKay, DDS, correlated high levels of fluoride with increased cases of dental fluorosis (a permanent damage to the enamel of the teeth that can occur in children from overexposure to fluoride) and demonstrated that reducing levels of fluoride resulted in lower rates of dental fluorosis.[11] [12] This work led H. Trendley Dean, DDS, to research fluoride's minimal threshold of toxicity in the water supply.[13] In work published in 1942, Dean suggested that lower levels of fluoride might result in lower rates of dental caries.[14]

While Dean worked to convince others to test his hypothesis about adding fluoride to community water supplies as a means of reducing caries, not everyone supported the idea. In fact, an editorial published in the *Journal of the American Dental Association* (JADA) in 1944 denounced purposeful water fluoridation and warned of its dangers:

> We do know the use of drinking water containing as little as 1.2 to 3.0 parts per million of fluorine will cause such developmental disturbances in bones as osteosclerosis, spondylosis, and osteopetrosis, as well as goiter, and we cannot afford to run the risk of producing such serious systemic disturbances in applying what is at present a doubtful procedure intended to prevent development of dental disfigurements among children.
>
> […] Because of our anxiety to find some therapeutic procedure that will promote mass prevention of caries, the seeming potentialities of fluorine appear speculatively attractive, but, in the light of our present knowledge or lack of knowledge of the chemistry of the subject, the potentialities for harm far outweigh those for good.[15]

A few months after this warning was issued, Grand Rapids, Michigan, became the first city to be artificially fluoridated on January 25, 1945. Dean had succeeded in his efforts to test his hypothesis, and in a landmark study, Grand Rapids was to serve as a test city, and its decay rates were to be compared with those of non-fluoridated Muskegon, Michigan. After only slightly more than five years, Muskegon was dropped as a control city, and the results published about the experiment only reported the decrease in caries in Grand Rapids.[16] Because the results did not include the control variable from the incomplete Muskegon data, many have stated that the initial studies presented in favor of water fluoridation were not even valid.

Concerns were made to the United States Congress in 1952 about potential dangers of water fluoridation, the lack of evidence as to its alleged usefulness in controlling dental caries, and the need for more research to be conducted.[17] Yet, in spite of these concerns and many others, experiments with fluoridated drinking water continued. By 1960, fluoridation of drinking water for alleged dental benefits had spread to over 50 million people in communities throughout the United States.[18]

Section 4: Overview of U.S. Artificial Water Fluoridation Regulations

In western Europe, some governments have openly recognized hazards of fluoride, and only 3% of the western European population drinks fluoridated water. [19] In the United States, over 66% of Americans are drinking fluoridated water.[20] Neither the Environmental Protection Agency (EPA) nor the federal government mandate water fluoridation in America, and the decision to fluoridate community water is made by the state or local municipality.[21] [22] However, the U.S. Public Health Service (PHS) establishes recommended fluoride concentrations in community drinking water for those who choose to fluoridate, and the Environmental Protection Agency (EPA) sets contaminant levels for public drinking water.

After water fluoridation in Grand Rapids, Michigan, began in 1945, the practice spread to locales across the country in the decades that followed. These efforts were encouraged by the Public Health Service (PHS) in the 1950s,[23] and in 1962, the PHS issued standards for fluoride in drinking water that would stand for 50 years. They stated that fluoride would prevent dental caries[24] and that optimal levels of fluoride added to drinking water should range between 0.7 to 1.2 milligrams per liter.[25] However, the PHS lowered this recommendation to the single level of 0.7 milligrams per liter in 2015 due to an increase in dental fluorosis (permanent damage to the teeth that can occur in children from overexposure to fluoride) and due to the increase in sources of fluoride exposure to Americans.[26]

Meanwhile, the Safe Drinking Water Act was established in 1974 to protect the quality of American drinking water, and it authorized the EPA to regulate public drinking water. Because of this legislation, the EPA can set *enforceable* maximum contaminant levels (MCLs) for drinking water, as well as *non-enforceable* maximum contaminant level goals (MCLGs) and *non-enforceable* drinking water standards of secondary maximum contaminant levels (SMCLs).[27] The EPA specifies that the MCLG is "the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, allowing an adequate margin of safety."[28] Additionally, the EPA qualifies that community water systems exceeding the MCL for fluoride "must notify persons served by that system as soon as practical, but no later than 30 days after the system learns of the violation."[29]

In 1975, the EPA set a maximum contaminant level (MCL) for fluoride in drinking water at 1.4 to 2.4 milligrams per liter.[30] They established this limit to prevent cases of dental fluorosis. In 1981, South Carolina argued that dental fluorosis is merely cosmetic, and the state petitioned the EPA to eliminate the MCL for fluoride.[31] As a result, in 1985, the EPA established a maximum contaminant level goal (MCLG) for fluoride at 4 milligrams per liter.[32] Rather than dental fluorosis serving as the protective endpoint (which would have required lower safety levels), this higher level was established as a means to protect against skeletal fluorosis, a bone disease caused by excess fluoride. Using skeletal fluorosis as the endpoint likewise resulted in a change for the MCL for fluoride, which was raised to 4 milligrams per liter in 1986.[33] Yet, dental fluorosis was applied as the endpoint for the SMCL for fluoride of 2 milligrams per liter, which was also set in 1986.[34]

Controversy ensued over these new regulations and even resulted in legal actions against the EPA. South Carolina argued that there was no need for any MCLG (maximum contaminant level goal) for fluoride, while the Natural Resources Defense Council argued that the MCLG should be lowered based on dental fluorosis.[35] A court ruled in the EPA's favor, but in a review of fluoride standards, the EPA enlisted the National Research Council (NRC) of the National Academy of Sciences to re-evaluate the health risks of fluoride.[36] [37]

The report from the National Research Council, released in 2006, concluded that the EPA's MCLG (maximum contaminant level goal) for fluoride should be lowered.[38] In addition to recognizing the potential for risk of fluoride and osteosarcoma (a bone cancer), the 2006 National Research Council report cited concerns about musculoskeletal effects, reproductive and developmental effects, neurotoxicity and neurobehavioral effects, genotoxicity and carcinogenicity, and effects on other organ systems.[39]

The NRC concluded that the MCLG for fluoride should be lowered in 2006, but the EPA has yet to lower the level.[40] In 2016, the Fluoride Action Network, the IAOMT, and a number of other groups and individuals petitioned the EPA to protect the public, especially susceptible subpopulations, from the neurotoxic risks of fluoride by banning the purposeful addition of fluoride to drinking water.[41] The petition was denied by the EPA in February 2017.[42]

Section 5: Health Effects of Fluoride

Since the NRC report was released in 2006, a number of other relevant research studies have been published. The discussion below includes a synopsis of some of the major research included in the 2006 NRC report, as well as some of the research of interest that has been published since that time.

Section 5.1: Skeletal System

Fluoride taken into the human body enters the bloodstream through the digestive tract.[43] Most of the fluoride that is not released through urine is stored in the body. It is generally stated that 99% of this fluoride resides in the bone,[44] where it is incorporated into the crystalline structure and accumulates over time.[45] Thus, it is indisputable that the teeth and bones are tissues of the body that concentrate the fluoride to which we are exposed.

In fact, in its 2006 report, the National Research Council (NRC)'s discussion on the danger of bone fractures from excessive fluoride was substantiated with significant research. Specifically, the report stated: "Overall, there was consensus among the committee that there is scientific evidence that under certain conditions fluoride can weaken bone and increase the risk of fractures."[46]

Section 5.1.1: Dental Fluorosis

Exposure to excess fluoride in children is known to result in dental fluorosis, a condition in which the teeth enamel becomes irreversibly damaged and the teeth become permanently discolored, displaying a white or brown mottling pattern and forming brittle teeth that break and stain easily.[47] It has been scientifically recognized since the 1940's that overexposure to fluoride causes this condition, which can range from very mild to severe. According to data from the Centers for Disease Control and Prevention (CDC) released in 2010, 23% of Americans aged 6-49 and 41% of children aged 12-15 exhibit fluorosis to some degree.[48] These drastic increases in rates of dental fluorosis were a crucial factor in the Public Health Service's decision to lower its water fluoridation level recommendations in 2015.[49]

Figure 1: Dental Fluorosis Ranging from Very Mild to Severe (Photos from Dr. David Kennedy and used with permission from victims of dental fluorosis.)

Section 5.1.2: Skeletal Fluorosis and Arthritis

Like dental fluorosis, skeletal fluorosis is an undeniable effect of overexposure to fluoride. Skeletal fluorosis causes denser bones, joint pain, a limited range of joint movement, and in severe cases, a completely rigid spine.[50] Although considered rare in the U.S., the condition does occur,[51] and it has been recently suggested that skeletal fluorosis could be more of a public health issue than previously recognized.[52]

As research published in 2016 noted, there is not yet a scientific consensus as to how much fluoride and/or how long levels of fluoride need to be taken in before skeletal fluorosis occurs.[53] While some authorities have suggested skeletal fluorosis only occurs after 10 years or more of exposure, research has shown that children can develop the disease in as little as six months,[54] and some adults have developed it in as little as two to seven years.[55] Similarly, while some authorities have suggested that 10 mg/day of fluoride is necessary to develop skeletal fluorosis, research has reported that much lower levels of exposure to fluoride (in some cases less than 2ppm) can also cause the disease.[56] Furthermore, research published in 2010 confirmed that skeletal tissue response to fluoride varies by individual.[57]

In patients with skeletal fluorosis, fluoride has also been suspected of causing secondary hyperparathyroidism and/or causing bone damage resembling secondary hyperparathyroidism. The condition, which commonly results from kidney disease, is triggered when the levels of calcium and phosphorous in the blood are too low.[58] A number of studies that have been collected by the Fluoride Action Network (FAN) examine the possibility that fluoride is one contributor to this health effect.[59]

Because arthritic symptoms are associated with skeletal fluorosis, arthritis is another area of concern in relation to fluoride exposures. Notably in this regard, research has linked fluoride to osteoarthritis, both with or without skeletal fluorosis.[60] Additionally, temporomandibular joint disorder (TMJ) has been associated with dental and skeletal fluorosis.[61]

Section 5.1.3: Cancer of the Bone, Osteosarcoma

In 2006, the NRC discussed a potential link between fluoride exposure and osteosarcoma. This type of bone cancer has been recognized as "the sixth most common group of malignant tumors in children and the third most common malignant tumor for adolescents."[62] The NRC stated that while evidence was tentative, fluoride appeared to have the potential to promote cancers.[63] They elucidated that osteosarcoma was of significant concern, especially because of fluoride deposition in bone and the mitogenic effect of fluoride on bone cells.[64]

While some studies have failed to find an association between fluoride and osteosarcoma, according to the research completed by Dr. Elise Bassin while at Harvard School of Dental Medicine, exposure to fluoride at recommended levels correlated with a seven-fold increase in osteosarcoma when boys were exposed between the ages of five and seven.[65] Bassin's research, published in 2006, is the only study about osteosarcoma that has taken age-specific risks into account.[66]

Section 5.2: Central Nervous System

The potential for fluorides to impact the brain have been well-established. In their 2006 report, the NRC explained: "On the basis of information largely derived from histological, chemical, and molecular studies, it is apparent that fluorides have the ability to interfere with the functions of the brain and the body by direct and indirect means."[67] Both dementia and Alzheimer's disease are also mentioned in the NRC report for consideration as being potentially linked to fluoride.[68]

These concerns have been substantiated. Studies about water fluoridation and IQ effects were closely examined in research published in October of 2012 in *Environmental Health Perspectives*.[69] In this meta-review, 12 studies demonstrated that communities with fluoridated water levels below 4 mg/L (average of 2.4 mg/L) had lower IQs than the control groups.[70] Since the publication of the 2012 review, a number of additional studies finding reduced IQs in communities with less than 4 mg/L of fluoride in the water have become available.[71] To be more precise, in a citizen petition to the EPA in 2016, Michael Connett, Esq., Legal Director of FAN, identified 23 studies reporting reduced IQ in areas with fluoride levels currently accepted as safe by the EPA.[72]

Moreover, in 2014, a review was published in *The Lancet* entitled "Neurobehavioral effects of developmental toxicity." In this review, fluoride was listed as one of 12 industrial chemicals known to cause developmental neurotoxicity in human beings.[73] The researchers warned: “Neurodevelopmental disabilities, including autism, attention-deficit hyperactivity disorder, dyslexia, and other cognitive impairments, affect millions of children worldwide, and some diagnoses seem to be increasing in frequency. Industrial chemicals that injure the developing brain are among the known causes for this rise in prevalence.”[74]

Section 5.3: Cardiovascular System

According to statistics published in 2016, heart disease is the leading cause of death for both men and women in the U.S., and it costs the country $207 billion annually.[75] Thus, recognizing the potential relationship between fluoride and cardiovascular problems is essential not only for safe measures to be established for fluoride but also for preventative measures to be established for heart disease.

An association between fluoride and cardiovascular problems has been suspected for decades. The 2006 NRC report described a study from 1981 by Hanhijärvi and Penttilä that reported elevated serum fluoride in patients with cardiac failure.[76] Fluoride has also been related to arterial calcification,[77] arteriosclerosis,[78] cardiac insufficiency,[79] electrocardiogram abnormalities,[80] hypertension,[81] and myocardial damage.[82] Additionally, researchers of a study from China published in 2015 concluded: “The results showed that, NaF [sodium fluoride], in a concentration dependent-manner and even at the low concentration of 2 mg/L, changed the morphology of the cardiomyocytes, reduced cell viability, increased the cardiac arrest rate, and enhanced the levels of apoptosis.”[83]

Section 5.4: Endocrine System

Fluoride’s effects on the endocrine system, which consists of glands that regulate hormones, have also been studied. In the 2006 NRC report, it was stated: “In summary, evidence of several types indicates that fluoride affects normal endocrine function or response; the effects of the fluoride-induced changes vary in degree and kind in different individuals.”[84] The 2006 NRC report further included a table demonstrating how extremely low doses of fluoride have been found to disrupt thyroid function, especially when there was a deficiency in iodine present.[85] In more recent years, the impact of fluoride on the endocrine system has been re-emphasized. A study published in 2012 included sodium fluoride on a list of endocrine disrupting chemicals (EDCs) with low-dose effects,[86] and the study was cited in a 2013 report from the United Nations Environment Programme and the World Health Organization.[87]

Meanwhile, increased rates of thyroid dysfunction have been associated with fluoride.[88] Research published in 2015 by researchers at the University of Kent in Canterbury, England, noted that higher levels of fluoride in drinking water could predict higher levels of hypothyroidism.[89] They further explained: “In many areas of the world, hypothyroidism is a major health concern and in addition to other factors—such as iodine deficiency—fluoride exposure should be considered as a contributing factor. The findings of the study raise particular concerns about the validity of community fluoridation as a safe public health measure.”[90] Other studies have supported the association between fluoride and hypothyroidism,[91] an increase in thyroid stimulating hormone (THS),[92] and iodine deficiency.[93]

According to statistics released by the Centers for Disease Control and Prevention (CDC) in 2014, 29.1 million people or 9.3% of the population have diabetes.[94] Again, the potential role of fluoride in this condition is essential to consider. The 2006 NRC report warned:

> The conclusion from the available studies is that sufficient fluoride exposure appears to bring about increases in blood glucose or impaired glucose tolerance in some individuals and to increase the severity of some types of diabetes. In general, impaired glucose metabolism appears to be associated with serum

or plasma fluoride concentrations of about 0.1 mg/L or greater in both animals and humans (Rigalli et al. 1990, 1995; Trivedi et al. 1993; de al Sota et al. 1997).[95]

Research has also associated diabetes with a reduced capacity to clear fluoride from the body,[96] as well as a syndrome (polydispsia-polyurea) that results in increased intake of fluoride,[97] and research has also linked insulin inhibition and resistance to fluoride.[98]

Also of concern is that fluoride appears to interfere with functions of the pineal gland, which helps control circadian rhythms and hormones, including the regulation of melatonin and reproductive hormones. Jennifer Luke of the Royal Hospital of London has identified high levels of fluoride accumulated in the pineal gland[99] and further demonstrated that these levels could reach up to 21,000 ppm, rendering them higher than the fluoride levels in the bone or teeth.[100] Other studies have linked fluoride to melatonin levels,[101] insomnia,[102] and early puberty in girls,[103] as well as lower fertility rates (including men) and reduced testosterone levels.[104]

Section 5.5: Renal System

Urine is a major route of excretion for fluoride taken into the body, and the renal system is essential for the regulation of fluoride levels in the body.[105 106] Urinary excretion of fluoride is influenced by urine pH, diet, presence of drugs, and other factors.[107] Researchers of a 2015 article published by the Royal Society of Chemistry explained: "Thus, plasma and the kidney excretion rate constitutes the physiologic balance determined by fluoride intake, uptake to and removal from bone and the capacity of fluoride clearance by the kidney."[108]

The 2006 NRC report likewise recognized the role of the kidney in fluoride exposures. They noted that it is not surprising for patients with kidney disease to have increased plasma and bone fluoride concentrations.[109] They further stated that human kidneys "have to concentrate fluoride as much as 50-fold from plasma to urine. Portions of the renal system may therefore be at higher risk of fluoride toxicity than most soft tissues."[110]

In light of this information, it makes sense that researchers have indeed linked fluoride exposures to problems with the renal system. More specifically, researchers from Toronto, Canada, demonstrated that dialysis patients with renal osteodystrophy had high levels of fluoride in the bone and concluded that "bone fluoride may diminish bone microhardness by interfering with mineralization."[111]

Section 5.6: Respiratory System

The effects of fluoride on the respiratory system are most clearly documented in literature about occupational exposures. Strictly from an occupational standpoint, the aluminum industry has been the subject of an array of investigations into fluoride's impact on the respiratory systems of workers. Evidence from a series of studies indicates a correlation between workers at aluminum plants, exposures to fluoride, and respiratory effects, such as emphysema, bronchitis, and diminished lung function.[112]

Section 5.7: Digestive System

Upon ingestion, including through fluoridated water, fluoride is absorbed by the gastrointestinal system where it has a half-life of 30 minutes.[113] The amount of fluoride absorbed is dependent upon calcium levels, with higher concentrations of calcium lowering gastrointestinal absorption.[114 115] Also, according to research published in 2015 by the American Institute of Chemical Engineers, fluoride's interaction in the gastrointestinal system "results in formation of hydrofluoric [HF] acid by reacting with hydrochloric [HCL] acid present in the stomach. Being highly corrosive, the HF acid so formed will destroy the stomach and intestinal lining with the loss of microvilli."[116]

Other areas of the digestive system are also known to be impacted by fluoride. For example, the 2006 NRC report called for more information about fluoride's effect on the liver: "It is possible that a lifetime ingestion of 5-10 mg/day from drinking water containing fluoride at 4 mg/L might turn out to have long-term effects on the liver, and this should be investigated in future epidemiologic studies."[117]

Section 5.8: Immune System

The immune system is yet another part of the body that can be impacted by fluoride. An essential consideration is that immune cells develop in the bone marrow, so the effect of fluoride on the immune system could be related to fluoride's prevalence in the skeletal system. The 2006 NRC report elaborated on this scenario:

> Nevertheless, patients who live in either an artificially fluoridated community or a community where the drinking water naturally contains fluoride at 4 mg/L have all accumulated fluoride in their skeletal systems and potentially have very high fluoride concentrations in their bones. The bone marrow is where immune cells develop and that could affect humoral immunity and the production of antibodies to foreign chemicals.[118]

Allergies and hypersensitivities to fluoride are another risk component related to the immune system. Research published in 1950's, 1960's, and 1970's showed that some people are hypersensitive to fluoride.[119] [120] More recent studies have confirmed this reality.[121]

Section 5.9: Integumentary System

Fluoride can also impact the integumentary system, which consists of the skin, exocrine glands, hair, and nails. In particular, reactions to fluoride have been linked to acne and other dermatological conditions.[122] [123] [124] [125] Additionally, hair and nails have been studied as biomarkers of fluoride exposure. [126] Nail clippings are capable of demonstrating chronic fluoride exposures,[127] and using fluoride concentrations in nails to identify children at risk for dental fluorosis has been examined.[128]

Section 6: Fluoride Exposure Levels

Due to increased rates of dental fluorosis and increased sources of exposure to fluoride, the Public Health Service (PHS) lowered its recommended levels of fluoride set at 0.7 to 1.2 milligrams per liter in 1962[129] to 0.7 milligrams per liter in 2015.[130] The need to update previously established fluoride levels is extremely urgent, as fluoride exposures have obviously surged for Americans since the 1940's, when community water fluoridation was first introduced.

Generally, the optimal exposure for fluoride has been defined as between 0.05 and 0.07 mg of fluoride per kilogram of body weight.[131] However, this level has been criticized for failing to directly assess how intake of fluoride is related to the occurrence or severity of dental caries and/or dental fluorosis.[132] To elaborate, in a 2009 longitudinal study, researchers at the University of Iowa noted the lack of scientific evidence for this intake level and concluded: "Given the overlap among caries/fluorosis groups in mean fluoride intake and extreme variability in individual fluoride intakes, firmly recommending an 'optimal' fluoride intake is problematic."[133]

In light of this disparity, as well as the fact that the established levels directly influence the amounts of fluoride to which consumers are exposed, it is essential to evaluate some of the established limits and recommendations for fluoride exposures. While a description of fluoride regulations is provided in Section 4 of this document, recommendations issued by other government groups are also important to consider. Comparing regulations and recommendations helps to exemplify the complexity of establishing levels, of enforcing levels, of utilizing them to protect *all* individuals, and of applying them to everyday life. To illustrate this point, Table 2 provides a comparison of recommendations from the Public Health Service (PHS), recommendations from the Institute of Medicine (IOM), and regulations from the Environmental Protection Agency (EPA).

Table 2: Comparison of PHS Recommendations, IOM Recommendations, and EPA Regulations for Fluoride Intake

TYPE OF FLUORIDE LEVEL	SPECIFIC FLUORIDE RECOMMENDATION/ REGULATION	SOURCE OF INFORMATION AND *NOTES*
Recommendation for Fluoride Concentration in Drinking Water for the Prevention of Dental Caries	0.7 mg per liter	U.S. Public Health Service (PHS)[134] *This is a non-enforceable recommendation.*
Dietary Reference Intake: Tolerable Upper Intake Level of Fluoride	Infants 0-6 mo. 0.7 mg/d Infants 6-12 mo. 0.9 mg/d Children 1-3 y 1.3 mg/d Children 4-8 y 2.2 mg/d Males 9->70 y 10 mg/d Females 9->70 y* 10 mg/d (*includes pregnancy and lactation)	Food and Nutrition Board, Institute of Medicine (IOM), National Academies[135] *This is a non-enforceable recommendation.*
Dietary Reference Intake: Recommended Dietary Allowances and Adequate Intakes	Infants 0-6 mo. 0.01 mg/d Infants 6-12 mo. 0.5 mg/d Children 1-3 y 0.7 mg/d Children 4-8 y 1.0 mg/d Males 9-13 y 2.0 mg/d Males 14-18 y 3.0 mg/d Males 19->70 y 4.0 mg/d Females 9-13 y 2.0 mg/d Females 14->70 y* 3.0 mg/d (*includes pregnancy and lactation)	Food and Nutrition Board, Institute of Medicine (IOM), National Academies[136] *This is a non-enforceable recommendation.*
Maximum Contaminant Level (MCL) of Fluoride from Public Water Systems	4.0 mg per liter	U.S. Environmental Protection Agency (EPA)[137] *This is an* ***enforceable*** *regulation.*
Maximum Contaminant Level Goal (MCLG) of Fluoride from Public Water Systems	4.0 mg per liter	U.S. Environmental Protection Agency (EPA)[138] *This is a non-enforceable regulation.*
Secondary Standard of Maximum Contaminant Levels (SMCL) of Fluoride from Public Water Systems	2.0 mg per liter	U.S. Environmental Protection Agency (EPA)[139] *This is a non-enforceable regulation.*

By interpreting these selected examples, it is obvious that the limits and recommendations for fluoride in food and water vary tremendously and, in their current state, would be nearly impossible for consumers to incorporate into daily life. It is also obvious that these levels do not consider a multitude of other fluoride exposures. This means that consumers are reliant upon policy makers to protect them by enacting *enforceable regulations* based upon accurate data. One issue is that accurate data does not exist for either collective sources or singular sources of fluoride exposure. Another issue is that fluoride is known to impact each individual differently.

Section 6.1: Individualized Responses and Susceptible Subgroups

Setting one universal level of fluoride as a recommended limit is also problematic because it does not take individualized responses into account. While age, weight, and gender are *sometimes* considered in recommendations, the current EPA regulations for water prescribe one level that applies to everyone, regardless of infants and children and their known susceptibilities to fluoride exposures. Such a "one dose fits all" level also fails to address allergies to fluoride, [140] genetic factors,[141] [142] [143] nutrient deficiencies,[144] and other personalized factors known to be pertinent to fluoride exposures.

The NRC recognized such individualized responses to fluoride numerous times in their 2006 publication,[145] and other research has affirmed this reality. For example, urine pH, diet, presence of drugs, and other factors have been identified as relative to the amount of fluoride excreted in the urine.[146] As another example, fluoride exposures of non-nursing infants were estimated to be 2.8-3.4 times that of adults.[147] The NRC further established that certain subgroups have water intakes that greatly vary from any type of assumed average levels:

> These subgroups include people with high activity levels (e.g., athletes, workers with physically demanding duties, military personnel); people living in very hot or dry climates, especially outdoor workers; pregnant or lactating women; and people with health conditions that affect water intake. Such health conditions include diabetes mellitus, especially if untreated or poorly controlled; disorders of water and sodium metabolism, such as diabetes insipidus; renal problems resulting in reduced clearance of fluoride; and short-term conditions requiring rapid rehydration, such as gastrointestinal upsets or food poisoning.[148]

Considering that the rate of diabetes is on the rise in the U.S., with over 9% (29 million) Americans impacted,[149] this particular subgroup is especially essential to factor into account. Furthermore, when added to the other subgroups mentioned in the NRC report above (including infants and children), it is apparent that hundreds of millions of Americans are at risk from the current levels of fluoride added to community drinking water.

The American Dental Association (ADA), a trade-based group that promotes water fluoridation,[150] has also recognized the issue of individual variance in fluoride intake. They have recommended for research to be conducted to "[i]dentify biomarkers (that is, distinct biological indicators) as an alternative to direct fluoride intake measurement to allow the clinician to estimate a person's fluoride intake and the amount of fluoride in the body."[151]

Additional comments from the ADA provide even more insight into individualized responses related to fluoride intake. The ADA has recommended to "[c]onduct metabolic studies of fluoride to determine the influence of environmental, physiological and pathological conditions on the pharmacokinetics, balance and effects of fluoride."[152] Perhaps most notably, the ADA has also acknowledged the susceptible subgroup of infants. In regard to infant exposure from fluoridated water used in baby formula, the ADA recommends following the American Academy of Pediatrics guideline that breastfeeding should be exclusively practiced until the child is six months old and continued until 12 months, unless contraindicated.[153]

While suggesting to exclusively breastfeed infants is certainly protective of their fluoride exposures, it is simply not practical for many American women today. The authors of a study published in 2008 in *Pediatrics* reported that only 50% of women continued to breast feed at six months and only 24% of women continued to breast feed at 12 months.[154]

What these statistics mean is that, due to infant formula mixed with fluoridated water, millions of infants most certainly exceed the optimal intake levels of fluoride based on their low weight, small size, and developing body. Hardy Limeback, PhD, DDS, a member of a 2006 National Research Council (NRC) panel on fluoride toxicity, and former President of the Canadian Association of Dental Research, has elaborated: "Newborn babies have undeveloped brains, and exposure to fluoride, a suspected neurotoxin, should be avoided."[155]

Section 6.2: Multiple Sources of Fluoride Exposure from Water and Food

Fluoridated water, including its direct consumption and its use in other beverages and food preparation, is generally considered the main source of fluoride exposure for Americans. The U.S. Public Health Service (PHS) has estimated that the average dietary intake (including water) of fluoride for adults living in areas with 1.0 mg/L fluoride in the water as between 1.4 to 3.4 mg/day (0.02-0.048 mg/kg/day) and for children in fluoridated areas as between 0.03 to 0.06 mg/kg/day.[156] Additionally, the Centers for Disease Control and Prevention (CDC) has reported that water and processed beverages can comprise 75% of a person's fluoride intake.[157]

The 2006 NRC report came to similar conclusions. The authors estimated just how much of overall fluoride exposures are attributable to water when compared to pesticides/air, background food, and toothpaste, and they wrote: "Assuming that all drinking-water sources (tap and non-tap) contain the same fluoride concentration and using the EPA default drinking-water intake rates, the drinking-water contribution is 67-92% at 1 mg/L, 80-96% at 2 mg/L, and 89-98% at 4 mg/L."[158] Yet, the levels of NRC's estimated fluoridated water intake rates were higher for athletes, workers, and individuals with diabetes.[159]

It is important to reiterate that the fluoride added to water is not only taken in through drinking tap water. The water is also used for growing crops, tending to livestock (and domestic pets), food preparation, and bathing. It is also used to create other beverages, and for this reason, significant levels of fluoride have been recorded in infant formula and commercial beverages, such as juice and soft drinks.[160] Significant levels of fluoride have also been recorded in alcoholic beverages, especially wine and beer.[161] [162]

In the exposure estimates provided in the 2006 NRC report, fluoride in food consistently ranked as the second largest source behind water.[163] Increased levels of fluoride in food can occur due to human activity, especially through food preparation and the use of pesticides and fertilizers.[164] Significant fluoride levels have been recorded in grapes and grape products.[165] Fluoride levels have also been reported in cow's milk due to livestock raised on fluoride-containing water, feed, and soil,[166] as well as processed chicken[167] (likely due to mechanical deboning, which leaves skin and bone particles in the meat.)[168]

An essential question about these levels of fluoride intake is just how much is harmful. A study about water fluoridation published in 2016 by Kyle Fluegge, PhD, of Case Western University, was conducted at the county level in 22 states from 2005-2010. Dr. Fluegge reported that his findings suggested that "a 1 mg increase in the county mean added fluoride significantly positively predicts a 0.23 per 1,000 person increase in age-adjusted diabetes incidence ($P < 0.001$) and a 0.17% increase in age-adjusted diabetes prevalence percent ($P < 0.001$)."[169] This led him to reasonably conclude that community water fluoridation is associated with epidemiological outcomes for diabetes.

Other studies have produced equally concerning results. A study published in 2011 found that children with 0.05 to 0.08 mg/L of fluoride in their serum had a 4.2 drop in IQ when compared to other children.[170] Meanwhile, a study published in 2015 found that IQ points dropped at urinary fluoride levels between 0.7 and 1.5 mg/L,[171] and another study published in 2015 linked fluoride at levels >0.7 mg/L with hyperthyroidism.[172] Additional research has established the threat of health effects of fluoride in the water at levels currently considered as safe.[173]

Section 6.3: Interactions of Fluoride with Other Chemicals

The concept of multiple chemicals interacting within the human body to produce ill-health should now be an essential understanding required for practicing modern-day medicine. Researchers Jack Schubert, E. Joan Riley, and Sylvanus A. Tyler addressed this highly relevant aspect of toxic substances in a scientific article published in 1978. Considering the prevalence of chemical exposures, they noted: "Hence, it is necessary to know the possible adverse effects of two or more agents in order to evaluate potential occupational and environmental hazards and to set permissible levels."[174]

The need to study the health outcomes caused by exposures to a variety of chemicals has also been reported by researchers affiliated with a database which tracks associations between approximately 180 human diseases or conditions and chemical contaminants. Supported by the Collaborative on Health and the Environment, the researchers for this project, Sarah Janssen, MD, PhD, MPH, Gina Solomon, MD, MPH, and Ted Schettler, MD, MPH, clarified:

> More than 80,000 chemicals have been developed, distributed, and discarded into the environment over the past 50 years. The majority of them have not been tested for potential toxic effects in humans or animals. Some of these chemicals are commonly found in air, water, food, homes, work places, and communities. Whereas the toxicity of one chemical may be incompletely understood, an understanding of the effect from exposures to mixtures of chemicals is even less complete.[175]

Clearly, the interaction of fluoride with other chemicals is crucial to understanding exposure levels and their impacts. While countless interactions have yet to be examined, several hazardous combinations have been established.

Aluminofluoride exposure occurs from ingesting a fluoride source *with* an aluminum source.[176] This synergistic exposure to fluoride and aluminum can occur through water, tea, food residue, infant formulas, aluminum-containing antacids or medications, deodorants, cosmetics, and glassware.[177] Authors of a research report published in 1999 described the hazardous synergy between these two chemicals: "In view of the ubiquity of phosphate in cell metabolism and together with the dramatic increase in the amount of reactive aluminum now found in ecosystems, aluminofluoride complexes represent a strong potential danger for living organisms including humans."[178]

Furthermore, fluoride, in its form of hydrofluosilicic acid (which is added to many water supplies to fluoridate the water), attracts manganese and lead (both of which can be present in certain types of plumbing pipes). Likely because of the affinity for lead, fluoride has been linked to higher blood lead levels in children,[179] especially in minority groups.[180] Lead is known to lower IQs in children,[181] and lead has even been linked to violent behavior.[182] [183] Other research supports the potential association of fluoride with violence.[184]

Section 7: Lack of Efficacy, Lack of Evidence, and Lack of Ethics

Section 7.1: Lack of Efficacy

The fluoride in many products is added because it allegedly reduces dental caries. The suggested benefits of this form of fluoride are related to its activity on teeth of inhibiting bacterial respiration of Streptococcus mutans, the bacterium that turns sugar and starches into a sticky acid that dissolves enamel.[185] In particular, the interaction of fluoride with the mineral component of teeth produces a fluorohydroxyapatite (FHAP or FAP), and the result of this action is said to be enhanced remineralization and reduced demineralization of the teeth. While there is scientific support for this mechanism of fluoride, it has also been established that fluoride primarily works to reduce tooth decay *topically* (i.e. scrubbing it directly onto to teeth with a toothbrush), as opposed to *systemically* (i.e. drinking or ingesting fluoride through water or other means).[186]

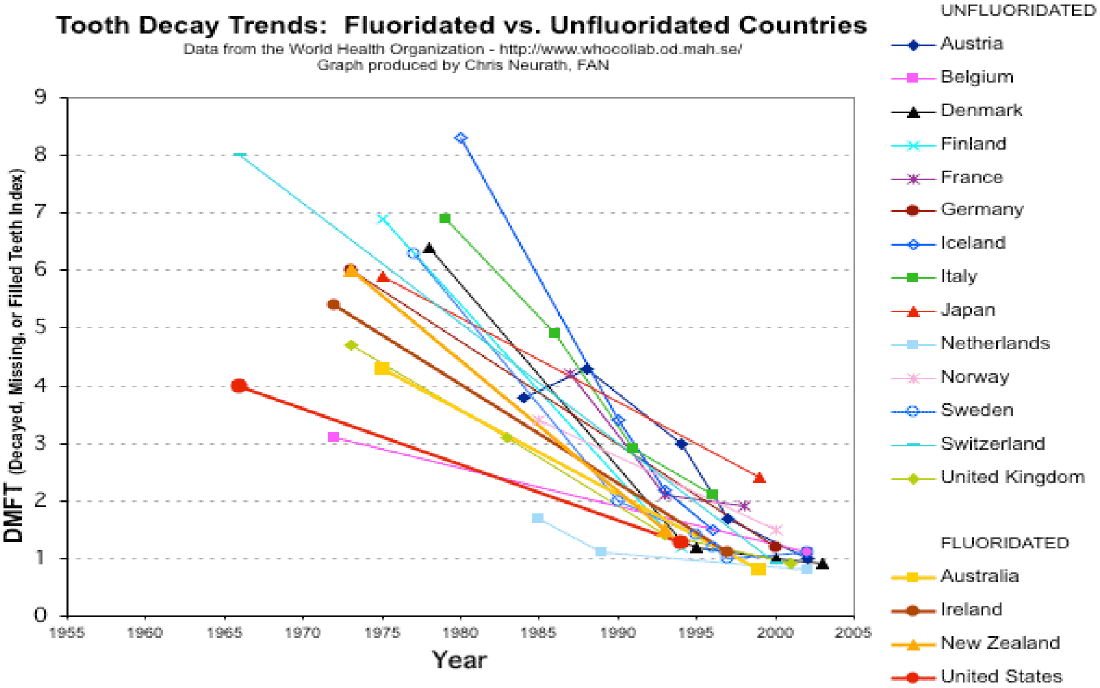
Although the *topical* benefits of fluoride have been distinctly expressed in scientific literature, research has likewise questioned these benefits. For example, researchers from the University of Massachusetts Lowell explained several controversies associated with topical uses of fluoride in an article published in the *Journal of Evidence-Based Dental Practice* in 2006. After citing a 1989 study from the National Institute of Dental Research that found minimal differences in children receiving fluoride and those not receiving fluoride, the authors referenced other studies demonstrating that cavity rates in industrialized countries have decreased without fluoride use.[187] The authors further referenced studies indicating that fluoride does not aid in preventing pit and fissure decay (which is the most prevalent form of tooth decay in the U.S.) or in preventing baby bottle tooth decay (which is prevalent in poor communities).[188]

As another example, early research used to support water fluoridation as a means of reducing dental caries was later re-examined, and the potential of misleading data was identified. Initially, the reduction of decayed and filled deciduous teeth (DFT) collected in research was interpreted as proof for the efficacy of water fluoridation. However, subsequent research by Dr. John A. Yiamouyiannis suggested that water fluoridation could have contributed to the delayed eruption of teeth.[189] Such delayed eruption would result in less teeth and therefore, the absence of decay, meaning that the lower rates of DFT were actually caused by the lack of teeth as opposed to the alleged effects of fluoride on dental caries.

Other examples in the scientific literature have questioned fluoride's use in preventing tooth decay. A 2014 review affirmed that fluoride's anti-caries effect is reliant upon calcium and magnesium in the tooth enamel but also that the remineralization process in tooth enamel is not dependent on fluoride.[190] Research published in 2010 identified that the concept of "fluoride strengthening teeth" could no longer be deemed as clinically significant to any decrease in caries linked to fluoride use.[191] Furthermore, research has suggested that *systemic* fluoride exposure has minimal (if any) effect on the teeth,[192] [193] and researchers have also offered data that dental fluorosis (the first sign of fluoride toxicity[194]) is higher in U.S. communities with fluoridated water as opposed to those without it.[195]

Still other reports show that as countries were developing, decay rates in the general population rose to a peak of four to eight decayed, missing, or filled teeth (in the 1960's) and then showed a dramatic decrease (to today's levels), regardless of fluoride use. It has been hypothesized that increased oral hygiene, access to preventative services, and more awareness of the detrimental effects of sugar are responsible for the visible decrease of tooth decay. Whatever the reasons might be, it should be noted that this trend of decreased tooth decay occurred with <u>and without</u> the systemic application of fluoridated water,[196] so it would appear that factors other than fluoride caused this change. Figure 2 below exhibits the tooth decay trends by fluoridated and non-fluoridated countries from 1955-2005.

Figure 2: Tooth Decay Trends in Fluoridated and Unfluoridated Countries, 1955-2005



Several other considerations are relevant in any decision about using fluoride to prevent caries. First, it should also be noted that fluoride is not an essential component for human growth and development.[197] Second, fluoride has been recognized as one of 12 chemicals "known to cause developmental neurotoxicity in human beings."[198] And finally, the American Dental Association (ADA) called for more research in 2013 in regard to the mechanism of fluoride action and effects:

> Research is needed regarding various topical fluorides to determine their mechanism of action and caries-preventive effects when in use at the current level of background fluoride exposure (that is, fluoridated water and fluoride toothpaste) in the United States. Studies regarding strategies for using fluoride to induce arrest or reversal of caries progression, as well as topical fluoride's specific effect on erupting teeth, also are needed.[199]

Section 7.2: Lack of Evidence

References to the unpredictability of levels at which fluoride's effects on the human system occur have been made throughout this position paper. However, it is important to reiterate the lack of evidence associated with fluoride usage, and thus, Table 3 provides an abbreviated list of stringent warnings from governmental, scientific, and other pertinent authorities about the dangers and uncertainties related to utilizing artificially fluoridated water.

Table 3: Selected Quotes about Fluoride Warnings Categorized by Product/Process and Source

PRODUCT/ PROCESS REFERENCED	QUOTE/S	SOURCE OF INFORMATION
Water fluoridation	"Fluoride exposure has a complex relationship in relation to dental caries and may increase dental caries risk in malnourished children due to calcium depletion and enamel hypoplasia..."	Peckham S, Awofeso N. Water fluoridation: a critical review of the physiological effects of ingested fluoride as a public health intervention. *The Scientific World Journal.* 2014 Feb 26; 2014.

Fluoride for dental uses, including water fluoridation	"The prevalence of dental caries in a population is not inversely related to the concentration of fluoride in enamel, and a higher concentration of enamel fluoride is not necessarily more efficacious in preventing dental caries." "Few studies evaluating the effectiveness of fluoride toothpaste, gel, rinse, and varnish among adult populations are available."	Centers for Disease Control and Prevention (CDC). Kohn WG, Maas WR, Malvitz DM, Presson SM, Shaddik KK. Recommendations for using fluoride to prevent and control dental caries in the United States. *Morbidity and Mortality Weekly Report: Recommendations and Reports*. 2001 Aug 17:i-42.
Fluoride in drinking water	"Overall, there was consensus among the committee that there is scientific evidence that under certain conditions fluoride can weaken bone and increase the risk of fractures."	National Research Council. *Fluoride in Drinking Water: A Scientific Review of EPA's Standards.* The National Academies Press: Washington, D.C. 2006.
Fluoride in drinking water	"The recommended Maximum Contaminant Level Goal (MCLG) for fluoride in drinking water should be zero."	Carton RJ. Review of the 2006 United States National Research Council Report: Fluoride in Drinking Water. *Fluoride*. 2006 Jul 1;39(3):163-72.
Fluoride in dental products, food, and drinking water	"Because the use of fluoridated dental products and the consumption of food and beverages made with fluoridated water have increased since HHS recommended optimal levels for fluoridation, many people now may be exposed to more fluoride than had been anticipated."	Tiemann M. Fluoride in drinking water: a review of fluoridation and regulation issues. *BiblioGov*. 2013 Apr 5. Congressional Research Service Report for Congress.
Fluoride intake in children	"The 'optimal' intake of fluoride has been widely accepted for decades as between 0.05 and 0.07 mg fluoride per kilogram of body weight but is based on limited scientific evidence." "These findings suggest that achieving a caries-free status may have relatively little to do with fluoride intake, while fluorosis is clearly more dependent on fluoride intake."	Warren JJ, Levy SM, Broffitt B, Cavanaugh JE, Kanellis MJ, Weber-Gasparoni K. Considerations on optimal fluoride intake using dental fluorosis and dental caries outcomes–a longitudinal study. *Journal of Public Health Dentistry*. 2009 Mar 1;69(2):111-5.

Review of safety standards for exposure to fluorine and fluorides	"If we were to consider only fluoride's affinity for calcium, we would understand fluoride's far-reaching ability to cause damage to cells, organs, glands, and tissues."	Prystupa J. Fluorine—a current literature review. An NRC and ATSDR based review of safety standards for exposure to fluorine and fluorides. *Toxicology Mechanisms and Methods.* 2011 Feb 1;21(2):103-70.

Section 7.3: Lack of Ethics

Another major concern about fluoride exposure from drinking water and food is related to the production of the fluorides used in community water supplies. According to the Centers for Disease Control and Prevention (CDC), three types of fluoride are generally used for community water fluoridation:

- Fluorosilicic acid: a water-based solution used by most water systems in the United States. Fluorosilicic acid is also referred to as hydrofluorosilicate, FSA, or HFS.
- Sodium fluorosilicate: a dry additive, dissolved into a solution before being added to water.
- Sodium fluoride: a dry additive, typically used in small water systems, dissolved into a solution before being added to water.[200]

Controversy has arisen over the industrial ties to these ingredients. The CDC has explained that phosphorite rock is heated with sulfuric acid to create 95% of the fluorosilicic acid used in water fluoridation.[201] The CDC has further explained: "Because the supply of fluoride products is related to phosphate fertilizer production, fluoride product production can also fluctuate depending on factors such as unfavorable foreign exchange rates and export sales of fertilizer."[202] A government document from Australia has more openly stated that hydrofluosilicic acid, sodium silicofluoride and sodium fluoride are *all* "commonly sourced from phosphate fertilizer manufacturers."[203] Safety advocates for fluoride exposures have questioned if such industrial ties are ethical and if the industrial connection to these chemicals might result in a cover-up of the health effects caused by fluoride exposures.

A specific ethical issue that arises with such industry involvement is that profit-driven groups seem to define the evolving requirements of what constitutes the "best" evidence-based research, and in the meantime, unbiased science becomes difficult to fund, produce, publish, and publicize. This is because funding a large-scale study can be very expensive, but industrial-based entities can easily afford to support their own researchers. They can also afford to spend time examining different ways of reporting the data (such as leaving out certain statistics to obtain a more favorable result), and they can further afford to publicize any aspect of the research that supports their activities. Unfortunately, history has shown that corporate entities can even afford to harass independent scientists as a means of ending their work if that work shows harm generated by industrial pollutants and contaminants.

Indeed, this scenario of unbalanced science has been recognized in fluoride research. Authors of a review published in *the Scientific World Journal* in 2014 elaborated: "Although artificial fluoridation of water supplies has been a controversial public health strategy since its introduction, researchers—whom include internationally respected scientists and academics—have consistently found it difficult to publish critical articles of community water fluoridation in scholarly dental and public health journals."[204]

In relation to the ethics of medical and dental practices, a cornerstone of public health policy known as the precautionary principle must be considered as well. The basic premise of this policy is built upon the centuries-old medical oath to "first, do no harm." Yet, the modern application of the precautionary principle is actually supported by an international agreement.

In January 1998, at an international conference involving scientists, lawyers, policy makers, and environmentalists from the U.S., Canada and Europe, a formalized statement was signed and became known as the "Wingspread Statement on the Precautionary Principle."[205] In it, the following advice is given: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof."[206]

Not surprisingly, the need for the appropriate application of the precautionary principle has been associated with fluoride usage. Authors of a 2006 article entitled "What Does the Precautionary Principle Mean for Evidence-Based Dentistry?" suggested the need to account for cumulative exposures from all fluoride sources and population variability, while also stating that consumers can reach "optimal" fluoridation levels without ever drinking fluoridated water.[207] Additionally, researchers of a review published in 2014 addressed the obligation for the precautionary principle to be applied to fluoride usage, and they took this concept one step further when they suggested that our modern-day understanding of dental caries "diminishes any major future role for fluoride in caries prevention."[208]

Section 8: Conclusion

Based upon the elevated number of fluoride sources and the increased rates of fluoride intake in the American population, which have risen substantially since water fluoridation began in the 1940's, lowering exposures to fluoride has become a necessary and viable alternative. For example, the author of a 2013 Congressional Report noted that significant levels of fluoride can be obtained from sources other than water.[209] As another example, researchers from the University of Kent in Canterbury, England, considered the quantity of fluoride sources and wrote in 2014 that "the prime public health priority in relation to fluoride is how to reduce ingestion from multiple sources, rather than adding this abundant and toxic chemical to water or food."[210]

The sources of human exposure to fluoride have drastically increased since community water fluoridation began in the U.S. in the 1940's. In addition to water, these sources now include food, air, soil, pesticides, fertilizers, dental products used at home and in the dental office (some of which are implanted in the human body), pharmaceutical drugs, cookware, clothing, carpeting, and an array of other consumer items used on a regular basis. Official regulations and recommendations on fluoride use, many of which are not enforced, have been based on limited research and have only been updated after evidence of harm has been produced and reported.

Exposure to fluoride is suspected of impacting every part of the human body, including the cardiovascular, central nervous, digestive, endocrine, immune, integumentary, renal, respiratory, and skeletal systems. Susceptible subpopulations, such as infants, children, and individuals with diabetes or renal problems, are known to be more severely impacted by intake of fluoride. Accurate fluoride exposure levels to consumers are unavailable; however, estimated exposure levels suggest that millions of people are at risk of experiencing the harmful effects of fluoride and even toxicity, the first visible sign of which is dental fluorosis. A lack of efficacy, lack of evidence, and lack of ethics are apparent in the current status quo of fluoride usage.

Informed consumer consent is needed for all uses of fluoride, and this pertains to water fluoridation, as well as all dental-based products, whether administered at home or in the dental office. Providing education about fluoride risks and fluoride toxicity to medical and dental professionals, medical and dental students, consumers, and policy makers is crucial to improving the future of public health.

There are fluoride-free strategies in which to prevent dental caries. **Given the current levels of exposure, policies should reduce and work toward eliminating avoidable sources of fluoride, including water fluoridation, fluoride-containing dental materials, and other fluoridated products, as means to promote dental and overall health.**

This document consists of excerpts taken from the document entitled "International Academy of Oral Medicine and Toxicology (IAOMT) Position Paper against Fluoride Use in Water, Dental Materials, and Other Products for Dental and Medical Practitioners, Dental and Medical Students, Consumers, and Policy Makers."
Click here to access the full document.

Endnotes:

[1] National Research Council. Health Effects of Ingested Fluoride. The National Academy Press: Washington, D.C. 1993. p. 30. *And* European Commission. Critical review of any new evidence on the hazard profile, health effects, and human exposure to fluoride and the fluoridating agents of drinking water. Scientific Committee on Health and Environmental Risks (SCHER). 2011. *See more in* Connett M. Fluoride is not an essential ingredient [Internet]. Fluoride Action Network. August 2012. Online at http://fluoridealert.org/studies/essential-nutrient/. Accessed November 1, 2016.

[2] *See Table 2 on page 334 of* Grandjean P, Landrigan PJ. Neurobehavioural effects of developmental toxicity. The Lancet Neurology. 2014 Mar 31;13(3):330-8.

[3] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 52.

[4] Prystupa J. Fluorine—a current literature review. An NRC and ATSDR based review of safety standards for exposure to fluorine and fluorides. Toxicology mechanisms and methods. 2011 Feb 1;21(2):103-70. Page 104.

[5] NobelPrize.Org. Henry Moissan facts [Internet]. Online at https://www.nobelprize.org/nobel_prizes/chemistry/laureates/1906/moissan-facts.html. Accessed November 2, 2016.

[6] Prystupa J. Fluorine—a current literature review. An NRC and ATSDR based review of safety standards for exposure to fluorine and fluorides. Toxicology mechanisms and methods. 2011 Feb 1;21(2):103-70. Page 104.

[7] http://pubs.acs.org/doi/pdf/10.1021/ac60086a019

[8] Mullenix PJ. Fluoride poisoning: a puzzle with hidden pieces. International Journal of Occupational and Environmental Health. 2005 Oct 1;11(4):404-14. Pages 405.

[9] Mullenix PJ. Fluoride poisoning: a puzzle with hidden pieces. International Journal of Occupational and Environmental Health. 2005 Oct 1;11(4):404-14. Page 404.

[10] *See, e.g., Riordan PJ. The place of fluoride supplements in caries prevention today. Australian Dental Journal 1996;41(5):335-42, at 335 ("Around the same time (late 1940s), fluoride supplements seem to have been marketed in the US. Fluoride supplements were being distributed regularly in US non-fluoridated areas in the early 1960s."), attached as Exhibit 9; Szpunar SM, Burt BA. Evaluation of appropriate use of dietary fluoride supplements in the US. Community Dentistry & Oral Epidemiology 1992;20(3):148-54, at 148 ("There is no firm documentation on when [fluoride supplements] first came onto the market, but it seems to have been in the mid-to-late 1940s."), attached as Exhibit 10.*
In Connett M. Citizen petition to FDA re: fluoride drops, tables, & lozenges. May 16, 2016. To the United States Food and Drug Administration (FDA) from the Fluoride Action Network (FAN) and the International Academy of Oral Medicine and Toxicology (IAOMT). Online at http://fluoridealert.org/wp-content/uploads/citizens_petition_supplements.pdf. Accessed November 2, 2016.

[11] McKay FS. Mottled Enamel: The Prevention of Its Further Production Through a Change of the Water Supply at Oakley, IDA. Journal of the American Dental Association. 1933 Jul 1;20(7):1137-49.

[12] Dean HT, McKay FS. Production of Mottled Enamel Halted by a Change in Common Water Supply. American Journal of Public Health and the Nations Health. 1939 Jun;29(6):590-6. Online at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1529429/pdf/amjphnation00995-0008.pdf. Accessed November 2, 2016.

[13] Dean HT, Elvove E. Further studies on the minimal threshold of chronic endemic dental fluorosis. Public Health Reports (1896-1970). 1937 Sep 10:1249-64.

[14] Dean HT, Arnold FA, Elvove E. Domestic water and dental caries. Public Health Rep. 1942 Aug 7;57(32):1155-79. Online at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1968063/pdf/pubhealthreporig01481-0001.pdf. Accessed November 2, 2016.

[15] Editorial Department (Anthony LP, editor). Effect of Fluorine on Dental Caries. *Journal of the American Dental Association.* 1944; 31:1360-1363.

[16] Lennon MA. One in a million: the first community trial of water fluoridation. Bulletin of the World Health Organization. 2006 Sep;84(9):759-60. Online at http://www.scielosp.org/scielo.php?pid=S0042-96862006000900020&script=sci_arttext. Accessed November 2, 2016.

[17] *See page 105-7 in* Prystupa J. Fluorine—a current literature review. An NRC and ATSDR based review of safety standards for exposure to fluorine and fluorides. Toxicology mechanisms and methods. 2011 Feb 1;21(2):103-70.

[18] Lennon MA. One in a million: the first community trial of water fluoridation. Bulletin of the World Health Organization. 2006 Sep;84(9):759-60. Online at http://www.scielosp.org/scielo.php?pid=S0042-96862006000900020&script=sci_arttext. Accessed November 2, 2016.

[19] *For a list of European countries that do not fluoridate drinking water and more information, see* Fluoride Action Network. Statements from European health, water, & environment authorities on water fluoridation [Internet]. 2007. Online at http://fluoridealert.org/content/europe-statements/. Accessed November 2, 2016.
[20] Centers for Disease Control and Prevention. Water fluoridation: fluoride statistics: 2014 [Internet]. Page last reviewed and updated August 19, 2016. Online at http://www.cdc.gov/fluoridation/statistics/2012stats.htm. Accessed November 2, 2016.
[21] United States Food and Drug Administration. August 5: Does the FDA regulate the use of fluoride in drinking water? Does a municipality which is adding fluoride to the drinking water need any special application, exemption or waiver to carry out the process of fluoridation in a drinking water system? [Internet]. Page last updated 2/19/2016. Online at http://www.fda.gov/drugs/newsevents/ucm363789.htm. Accessed November 2, 2016.
[22] *See also* Fluoride Action Network. Mandatory fluoridation in the U.S. [Internet]. Updated 2015. Online at http://fluoridealert.org/content/mandatory-fluoridation-in-the-u-s/. Accessed November 2, 2016.
[23] Peckham S, Awofeso N. Water fluoridation: a critical review of the physiological effects of ingested fluoride as a public health intervention. The Scientific World Journal. 2014 Feb 26;2014. Online at http://downloads.hindawi.com/journals/tswj/2014/293019.pdf. Accessed November 2, 2016.
[24] United States Department of Health, Education, and Welfare. Public Health Service Drinking Water Standards Revised 1962. Washington, D.C.: Public Health Service. 1962. Page 41. Online at https://nepis.epa.gov/Exe/ZyPDF.cgi/2000TP5L.PDF?Dockey=2000TP5L.PDF. Accessed November 2, 2016.
[25] United States Department of Health, Education, and Welfare. Public Health Service Drinking Water Standards Revised 1962. Washington, D.C.: Public Health Service. 1962. Page 8. Online at https://nepis.epa.gov/Exe/ZyPDF.cgi/2000TP5L.PDF?Dockey=2000TP5L.PDF. Accessed November 2, 2016.
[26] United States Department of Health and Human Services. HHS issues final recommendation for community water fluoridation [Press release]. April 27, 2015. Online at http://www.hhs.gov/about/news/2015/04/27/hhs-issues-final-recommendation-for-community-water-fluoridation.html. Accessed November 2, 2016.
[27] United States Environmental Protection Agency. Sulfuryl fluoride; proposed order granting objections to tolerances and denying request for a stay. Document number 2011-917. Washington, D.C.: Federal Register. 2011. Page 3248. Online at https://www.federalregister.gov/documents/2011/01/19/2011-917/sulfuryl-fluoride-proposed-order-granting-objections-to-tolerances-and-denying-request-for-a-stay. Accessed November 2, 2016.
[28] United States Environmental Protection Agency. How EPA regulates drinking water contaminants [Internet]. Online at https://www.epa.gov/dwregdev/how-epa-regulates-drinking-water-contaminants. Accessed February 24, 2017.
[29] United States Environmental Protection Agency. Questions and answers on fluoride [Internet]. Online at https://www.epa.gov/sites/production/files/2015-10/documents/2011_fluoride_questionsanswers.pdf. Accessed November 2, 2016.
[30] 40 FR 59566, December 24, 1975 *In* United States Environmental Protection Agency. Sulfuryl fluoride; proposed order granting objections to tolerances and denying request for a stay. Document number 2011-917. Washington, D.C.: Federal Register. 2011. Page 3248. Online at https://www.federalregister.gov/documents/2011/01/19/2011-917/sulfuryl-fluoride-proposed-order-granting-objections-to-tolerances-and-denying-request-for-a-stay. Accessed November 2, 2016.
[31] 50 FR 20164, May 14, 1985 *In* United States Environmental Protection Agency. Sulfuryl fluoride; proposed order granting objections to tolerances and denying request for a stay. Document number 2011-917. Washington, D.C.: Federal Register. 2011. Page 3248. Online at https://www.federalregister.gov/documents/2011/01/19/2011-917/sulfuryl-fluoride-proposed-order-granting-objections-to-tolerances-and-denying-request-for-a-stay. Accessed November 2, 2016.
[32] 50 FR 47142, November 14, 1985 *In* United States Environmental Protection Agency. Sulfuryl fluoride; proposed order granting objections to tolerances and denying request for a stay. Document number 2011-917. Washington, D.C.: Federal Register. 2011. Page 3248. Online at https://www.federalregister.gov/documents/2011/01/19/2011-917/sulfuryl-fluoride-proposed-order-granting-objections-to-tolerances-and-denying-request-for-a-stay. Accessed November 2, 2016.
[33] 51 FR 11396, April 2, 1986 *In* United States Environmental Protection Agency. Sulfuryl fluoride; proposed order granting objections to tolerances and denying request for a stay. Document number 2011-917. Washington, D.C.: Federal Register. 2011. Page 3248. Online at https://www.federalregister.gov/documents/2011/01/19/2011-917/sulfuryl-fluoride-proposed-order-granting-objections-to-tolerances-and-denying-request-for-a-stay. Accessed November 2, 2016.
[34] 51 FR 11396, April 2, 1986 *In* United States Environmental Protection Agency. Sulfuryl fluoride; proposed order granting objections to tolerances and denying request for a stay. Document number 2011-917. Washington, D.C.: Federal Register. 2011. Page 3248. Online at https://www.federalregister.gov/documents/2011/01/19/2011-917/sulfuryl-fluoride-proposed-order-granting-objections-to-tolerances-and-denying-request-for-a-stay. Accessed November 2, 2016.
[35] United States Environmental Protection Agency. Sulfuryl fluoride; proposed order granting objections to tolerances and denying request for a stay. Document number 2011-917. Washington, D.C.: Federal Register. 2011. Page 3248. Online at https://www.federalregister.gov/documents/2011/01/19/2011-917/sulfuryl-fluoride-proposed-order-granting-objections-to-tolerances-and-denying-request-for-a-stay. Accessed November 2, 2016.
[36] Tiemann M. Fluoride in drinking water: a review of fluoridation and regulation issues. Congressional Research Service Report for Congress. BiblioGov. 2013 Apr 5. Online at https://www.fas.org/sgp/crs/misc/RL33280.pdf. Accessed November 2, 2016.
[37] United States Environmental Protection Agency. Sulfuryl fluoride; proposed order granting objections to tolerances and denying request for a stay. Document number 2011-917. Washington, D.C.: Federal Register. 2011. Page 3248. Online at https://www.federalregister.gov/documents/2011/01/19/2011-917/sulfuryl-fluoride-proposed-order-granting-objections-to-tolerances-and-denying-request-for-a-stay. Accessed November 2, 2016.
[38] National Research Council. *Fluoride in Drinking Water: A Scientific Review of EPA's Standards.* The National Academies Press: Washington, D.C. 2006.

[39] National Research Council. *Fluoride in Drinking Water: A Scientific Review of EPA's Standards.* The National Academies Press: Washington, D.C. 2006.
[40] Connett M. Citizen petition under Toxic Substances Control Act regarding the neurotoxic risks posed by fluoride compounds in drinking water. November 22, 2016. To the United States Department of Environmental Protection (EPA) by the Fluoride Action Network (FAN), the International Academy of Oral Medicine and Toxicology (IAOMT), the American Academy of Environmental Medicine (AAEM), Food & Water Watch (FWW), Moms Against Fluoridation, the Organic Consumers Association, Audrey Adams, Jacqueline Denton, Valerie Green, Kristin Lavelle, and Brenda Staudenmaier. Online at http://fluoridealert.org/wp-content/uploads/epa-petition.pdf. Accessed March 31, 2017.
[41] Connett M. Citizen petition under Toxic Substances Control Act regarding the neurotoxic risks posed by fluoride compounds in drinking water. November 22, 2016. To the United States Department of Environmental Protection (EPA) by the Fluoride Action Network (FAN), the International Academy of Oral Medicine and Toxicology (IAOMT), the American Academy of Environmental Medicine (AAEM), Food & Water Watch (FWW), Moms Against Fluoridation, the Organic Consumers Association, Audrey Adams, Jacqueline Denton, Valerie Green, Kristin Lavelle, and Brenda Staudenmaier. Online at http://fluoridealert.org/wp-content/uploads/epa-petition.pdf. Accessed March 31, 2017.
[42] United States Environmental Protection Agency. Fluoride Chemicals in Drinking Water; TSCA Section 21 Petition; Reasons for Agency Response. EPA-HQ-OPPT-2016-0763. Online at https://www.epa.gov/sites/production/files/2017-02/documents/fluoridetsca21_frn_prepub_2017-02-17.pdf. Accessed March 16, 2017.
[43] Agency for Toxic Substances and Disease Registry. Public health statement for fluorides, hydrogen fluoride, and fluorine [Internet]. September 2003. Online at https://www.atsdr.cdc.gov/phs/phs.asp?id=210&tid=38. Accessed November 3, 2016.
[44] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 131.
[45] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 5.
[46] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 7.
[47] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006.
[48] Centers for Disease Control and Prevention. Prevalence and severity of dental fluorosis in the United States, 1999-2004. NCHS Data Brief No. 53. November 2010. Online at http://www.cdc.gov/nchs/data/databriefs/db53.htm. Accessed November 3, 2016.
[49] United States Department of Health and Human Services. HHS issues final recommendation for community water fluoridation [Press release]. April 27, 2015. Online at http://www.hhs.gov/about/news/2015/04/27/hhs-issues-final-recommendation-for-community-water-fluoridation.html. Accessed November 2, 2016.
[50] Agency for Toxic Substances and Disease Registry. Public health statement for fluorides, hydrogen fluoride, and fluorine [Internet]. September 2003. Online at https://www.atsdr.cdc.gov/phs/phs.asp?id=210&tid=38. Accessed November 3, 2016.
[51] Izuora K, Twombly JG, Whitford GM, Demertzis J, Pacifici R, Whyte MP. Skeletal fluorosis from brewed tea. The Journal of Clinical Endocrinology & Metabolism. 2011 May 18;96(8):2318-24. Online at http://press.endocrine.org/doi/full/10.1210/jc.2010-2891. Accessed November 3, 2016.
[52] Nelson EA. Possible Fluoride Toxicity in North America: a paleopathological assessment and discussion of modern occurrence [Thesis]. Fort Worth, Texas: University of North Texas Health Science Center. 2015. Online at http://digitalcommons.hsc.unt.edu/theses/849/. Accessed November 3, 2016.
[53] Nelson EA, Halling CL, Buikstra JE. Investigating fluoride toxicity in a Middle Woodland population from west-central Illinois: A discussion of methods for evaluating the influence of environment and diet in paleopathological analyses. Journal of Archaeological Science: Reports. 2016 Feb 29;5:664-71.
[54] Teotia M, Teotia SP, Singh KP. Endemic chronic fluoride toxicity and dietary calcium deficiency interaction syndromes of metabolic bone diease and deformities in India: Year 2000. The Indian Journal of Pediatrics. 1998 May 1;65(3):371-81.
In Fluoride Action Network. Skeletal fluorosis [Internet]. Online at http://fluoridealert.org/issues/health/skeletal_fluorosis/. Accessed November 3, 2016.
[55] Felsenfeld AJ, Roberts MA. A report of fluorosis in the United States secondary to drinking well water. JAMA. 1991 Jan 23;265(4):486-8. *In* Fluoride Action Network. Skeletal fluorosis [Internet]. Online at http://fluoridealert.org/issues/health/skeletal_fluorosis/. Accessed November 3, 2016.
[56] Misra UK, Nag D, Ray PK, Husain M, Newton G. Endemic fluorosis presenting as cervical cord compression. Archives of Environmental Health: An International Journal. 1988 Feb 1;43(1):18-21.
And Littleton J. Paleopathology of skeletal fluorosis. American journal of physical anthropology. 1999 Aug 1;109(4):465-83.
And more at Connett M. Skeletal fluorosis in India and China [Internet]. May 2012. Online at http://fluoridealert.org/studies/skeletal_fluorosis05/. Accessed November 3, 2016.
See also Johnson W, Taves DR, Jowsey J. Fluoridation and bone disease in renal patients. In Continuing Evaluation of the Use of Fluorides. AAAS Selected Symposium. Westview Press, Boulder, Colorado 1979 (pp. 275-293).
[57] Chachra D, Limeback H, Willett TL, Grynpas MD. The long-term effects of water fluoridation on the human skeleton. Journal of Dental Research. 2010 Nov 1;89(11):1219-23.
[58] *See* Connett M. Fluoride and secondary hyperparathyroidism [Internet]. May 2012. Online at http://fluoridealert.org/studies/skeletal_fluorosis13_/. Accessed November 3, 2016.

[59] Gupta SK, Gupta RC, Gupta K, Trivedi HP. Changes in serum seromucoid following compensatory Hyperparathyroidism: a sequel to chronic fluoride ingestion. Indian Journal of Clinical Biochemistry. 2008 Apr 1;23(2):176-80. Online at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3453077/pdf/12291_2008_Article_39.pdf. Accessed November 3, 2016.
And Koroglu BK, Ersoy IH, Koroglu M, Balkarli A, Ersoy S, Varol S, Tamer MN. Serum parathyroid hormone levels in chronic endemic fluorosis. Biological Trace Element Research. 2011 Oct 1;143(1):79-86.
And more in Connett M. Fluoride and secondary hyperparathyroidism [Internet]. May 2012. Online at http://fluoridealert.org/studies/skeletal_fluorosis13_/. Accessed November 3, 2016.
[60] Savas S, Çetin M, Akdoğan M, Heybeli N. Endemic fluorosis in Turkish patients: relationship with knee osteoarthritis. Rheumatology International. 2001 Sep 1;21(1):30-5.
And Czerwinski E, Nowak J, Dabrowska D, Skolarczyk A, Kita B, Ksiezyk M. Bone and joint pathology in fluoride-exposed workers. Archives of Environmental Health: An International Journal. 1988 Oct 1;43(5):340-3.
And more in Fluoride Action Network. Arthritis [Internet]. Online at http://fluoridealert.org/issues/health/arthritis/. Accessed November 3, 2016.
[61] Asawa K, Singh A, Bhat N, Tak M, Shinde K, Jain S. Association of Temporomandibular Joint Signs & Symptoms with Dental Fluorosis & Skeletal Manifestations in Endemic Fluoride Areas of Dungarpur District, Rajasthan, India. Journal of clinical and diagnostic research: JCDR. 2015 Dec;9(12):ZC18. Online at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4717726/. Accessed November 3, 2016.
[62] Bassin EB, Wypij D, Davis RB, Mittleman MA. Age-specific fluoride exposure in drinking water and osteosarcoma. Cancer Causes & Control. 2006; 17(4): 421-428.
[63] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 336.
[64] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 336.
[65] Bassin EB, Wypij D, Davis RB, Mittleman MA. Age-specific fluoride exposure in drinking water and osteosarcoma. Cancer Causes & Control. 2006; 17(4): 421-428.
[66] Fluoride Action Network. Cancer [Internet]. Online at http://fluoridealert.org/issues/health/cancer/. Accessed November 3, 2016.
[67] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 222.
[68] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Pages 222-3.
[69] Choi AL, Sun G, Zhang Y, Grandjean P. Developmental fluoride neurotoxicity: a systematic review and meta-analysis. Environmental Health Perspectives. 2012; 120(10):1362-1368. Online at https://dash.harvard.edu/bitstream/handle/1/10579664/3491930.pdf. Accessed November 3, 2016.
[70] Choi AL, Sun G, Zhang Y, Grandjean P. Developmental fluoride neurotoxicity: a systematic review and meta-analysis. Environmental Health Perspectives. 2012; 120(10):1362-1368. Online at https://dash.harvard.edu/bitstream/handle/1/10579664/3491930.pdf. Accessed November 3, 2016.
[71] *See* Connett M. Citizen petition under Toxic Substances Control Act regarding the neurotoxic risks posed by fluoride compounds in drinking water. November 22, 2016. To the United States Department of Environmental Protection (EPA) by the Fluoride Action Network (FAN), the International Academy of Oral Medicine and Toxicology (IAOMT), the American Academy of Environmental Medicine (AAEM), Food & Water Watch (FWW), Moms Against Fluoridation, the Organic Consumers Association, Audrey Adams, Jacqueline Denton, Valerie Green, Kristin Lavelle, and Brenda Staudenmaier. Online at http://fluoridealert.org/wp-content/uploads/epa-petition.pdf. Accessed March 31, 2017.
[72] *Additional studies finding reduced IQ in communities with less than 4 mg/L have become available in the years since Choi's review, including Sudhir et al. 2009 (0.7 to 1.2 mg/L); Zhang S. et al. 2015 (1.4 mg/L), Das & Mondal 2016 (2.1 mg/L), Choi et al. 2015 (2.2 mg/L), Sebastian & Sunitha 2012 (2.2 mg/L); Trivedi et al. 2012 (2.3 mg/L), Khan et al. 2015 (2.4 mg/L); Nagarajappa et al. 2013 (2.4 to 3.5 mg/L), Seraj et al. 2012 (3.1 mg/L), and Karimzade et al. 2014a,b (3.94 mg/L). Another study (Ding et al. 2011), which did not fit within Choi's dichotomous exposure criteria, found reduced IQ in an area with fluoride levels ranging from 0.3 to 3 mg/L. In total, there are now 23 studies reporting statistically significant reductions in IQ in areas with fluoride levels currently deemed safe by the EPA (less than 4 mg/L). [The 23 studies include the 10 studies listed in Table 1, the 11 studies listed in the paragraph above, and the studies by Eswar et al. (2011) and Shivaprakash et al. (2011).]*
In Connett M. Citizen petition under Toxic Substances Control Act regarding the neurotoxic risks posed by fluoride compounds in drinking water. November 22, 2016. To the United States Department of Environmental Protection (EPA) by the Fluoride Action Network (FAN), the International Academy of Oral Medicine and Toxicology (IAOMT), the American Academy of Environmental Medicine (AAEM), Food & Water Watch (FWW), Moms Against Fluoridation, the Organic Consumers Association, Audrey Adams, Jacqueline Denton, Valerie Green, Kristin Lavelle, and Brenda Staudenmaier. Online at http://fluoridealert.org/wp-content/uploads/epa-petition.pdf. Accessed March 31, 2017.
[73] *See Table 2 on page 334 of* Grandjean P, Landrigan PJ. Neurobehavioural effects of developmental toxicity. The Lancet Neurology. 2014 Mar 31;13(3):330-8.
[74] Grandjean P, Landrigan PJ. Neurobehavioural effects of developmental toxicity. The Lancet Neurology. 2014 Mar 31;13(3):330-8.
[75] Mozzafarian D, Benjamin EJ, Go AS, et al. on behalf of the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2016 update: a report from the American Heart Association. Circulation. 2016;133:e38-e360.
In Centers for Disease Control and Prevention. Heart disease fact sheet [Internet]. Page last updated and reviewed June 16, 2016. Online at http://www.cdc.gov/dhdsp/data_statistics/fact_sheets/fs_heart_disease.htm. Accessed November 3, 2016.

[76] Hanhijärvi H, Penttilä I. The relationship between human ionic plasma fluoride and serum creatinine concentrations in cases of renal and cardiac insufficiency in a fluoridated community. Proceedings of the Finnish Dental Society. Suomen Hammaslääkäriseuran toimituksia. 1981;77(6):330.
In National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 100.
[77] Tuncel E. The incidence of Moenckeberg calcifications in patients with endemic fluorosis. Fluoride. 1984 Jan 1;17(1):4-8.
And Susheela AK, Kharb P. Aortic calcification in chronic fluoride poisoning: biochemical and electronmicroscopic evidence. Experimental and Molecular Pathology. 1990 Aug 31;53(1):72-80.
In Fluoride Action Network. Cardiovascular [Internet]. http://fluoridealert.org/issues/health/cardio/. Accessed November 3, 2016.
[78] Song AH, Wang TY, Jiang CY, Zhang ZB, Wang ZS. Observations on fluorotic aorta sclerosis by two dimensional echo cardiography. Endem Dis Bull. 1990;5:91-4.
And Varol E, Akcay S, Ersoy IH, Ozaydin M, Koroglu BK, Varol S. Aortic elasticity is impaired in patients with endemic fluorosis. Biological Trace Element Research. 2010 Feb 1;133(2):121-7.
In Fluoride Action Network. Cardiovascular [Internet]. http://fluoridealert.org/issues/health/cardio/. Accessed November 3, 2016.
[79] Hanhijärvi H, Penttilä I, Hakulinen A. Ionic plasma fluoride concentrations related to some diseases in patients from a fluoridated community. Proceedings of the Finnish Dental Society. Suomen Hammaslaakariseuran Toimituksia. 1980 Dec;77(6):324-9.
In Fluoride Action Network. Cardiovascular [Internet]. http://fluoridealert.org/issues/health/cardio/. Accessed November 3, 2016.
[80] Karademir S, Akçam M, Kuybulu AE, Olgar S, Öktem F. Effects of fluorosis on QT dispersion, heart rate variability and echocardiographic parameters in children/Çocuklarda QT dispersiyonu, kalp hizi degiskenligi ve ekokardiyografik parametrelere florozisin etkileri. Anadulu Kardiyoloji Dergisi: AKD. 2011 Mar 1;11(2):150.
And Xu R, Xu R. Electrocardiogram analysis of patients with skeletal fluorosis. Fluoride. 1997 Feb 1;30(1):16-8.
In Fluoride Action Network. Cardiovascular [Internet]. http://fluoridealert.org/issues/health/cardio/. Accessed November 3, 2016.
[81] Amini H, Shahri SM, Amini M, Mehrian MR, Mokhayeri Y, Yunesian M. Drinking water fluoride and blood pressure? An environmental study. Biological Trace Element Research. 2011 Dec 1;144(1-3):157-63.
In Fluoride Action Network. Cardiovascular [Internet]. http://fluoridealert.org/issues/health/cardio/. Accessed November 3, 2016.
[82] Barbier O, Arreola-Mendoza L, Del Razo LM. Molecular mechanisms of fluoride toxicity. Chemico-Biological Interactions. 2010 Nov 5;188(2):319-33.
And Pribilla, O., 1968. Four cases of acute silicofluoride intoxication: clinical and pathological findings. *Fluoride*, *1*, pp.102-9.
And Takamori T, Miyanaga S, Kawahara H, OKU-SHI I, Hirao M, Wakatsuki H, Imura Z. Elecirocardiographical Studies of the Inhabitants in High Fluorine Districts. Tokushima Journal of Experimental Medicine. 1956 May;3(1):50-3.
And Varol E, Varol S. Effect of fluoride toxicity on cardiovascular systems: role of oxidative stress. Archives of toxicology. 2012. DOI 10.1007/s00204-012-0862-y.
In Fluoride Action Network. Cardiovascular [Internet]. http://fluoridealert.org/issues/health/cardio/. Accessed November 3, 2016.
[83] Yan X, Ren Q, Hao X, Chang N, Xu G, Wu L, Cheng RY. Sodium fluoride induces apoptosis and alters the cardiac arrest rate in primary cardiomyocytes. Fluoride. 2015 Jul 1;48(3):234-40.
[84] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 266.
[85] See Table 8-2 and discussion in National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Pages 236 and 238.
[86] Vandenberg LN, Colborn T, Hayes TB, Heindel JJ, Jacobs Jr DR, Lee DH, Shioda T, Soto AM, vom Saal FS, Welshons WV, Zoeller RT. Hormones and endocrine-disrupting chemicals: low-dose effects and nonmonotonic dose responses. Endocrine reviews. 2012 Mar 14;33(3):378-455.
In Fluoride Action Network. Endocrine system [Internet]. Online at http://fluoridealert.org/issues/health/endocrine/. Accessed November 3, 2016.
[87] *The Vanderberg et al. paper was cited in a larger report, Science of Endocrine Disrupting Chemicals – 2012, co-published in January 2013 by the United Nations Environment Programme and the World Health Organization – see page 13.*
In Fluoride Action Network. Endocrine system [Internet]. Online at http://fluoridealert.org/issues/health/endocrine/. Accessed November 3, 2016.
[88] Bachinskiĭ PP, Gutsalenko OA, Naryzhniuk ND, Sidora VD, Shliakhta AI. [Action of the body fluorine of healthy persons and thyroidopathy patients on the function of hypophyseal-thyroid the system]. Problemy Endokrinologii. 1984 Dec;31(6):25-9.
And Mikhailets ND, Balabolkin MI, Rakitin VA, Danilov IP. Functional state of thyroid under extended exposure to fluorides. Probl Endokrinol (Mosk). 1996;2:10.
And more in Fluoride Action Network. Thyroid [Internet]. Online at http://fluoridealert.org/issues/health/thyroid/. Accessed November 3, 2016.
[89] Peckham S, Lowery D, Spencer S. Are fluoride levels in drinking water associated with hypothyroidism prevalence in England? A large observational study of GP practice data and fluoride levels in drinking water. Journal of Epidemiology and Community Health. 2015 Jul 1;69(7):619-24.
[90] Peckham S, Lowery D, Spencer S. Are fluoride levels in drinking water associated with hypothyroidism prevalence in England? A large observational study of GP practice data and fluoride levels in drinking water. Journal of Epidemiology and Community Health. 2015 Jul 1;69(7):619-24.
[91] Bachinskiĭ PP, Gutsalenko OA, Naryzhniuk ND, Sidora VD, Shliakhta AI. [Action of the body fluorine of healthy persons and thyroidopathy patients on the function of hypophyseal-thyroid the system]. Problemy Endokrinologii. 1984 Dec;31(6):25-9.

And Mikhailets ND, Balabolkin MI, Rakitin VA, Danilov IP. Functional state of thyroid under extended exposure to fluorides. Probl Endokrinol (Mosk). 1996;2:10.
And Susheela AK, Bhatnagar M, Vig K, Mondal NK. Excess fluoride ingestion and thyroid hormone derangements in children living in Delhi, India. Fluoride. 2005 May 1;38(2):98-108.
And Yao Y. Analysis on TSH and intelligence level of children with dental Fluorosis in a high fluoride area. Literature and Information on Preventive Medicine. 1996;2(1):26-7.
And Yu Y. Study on serum T4, T3, and TSH levels in patients with chronic skeletal fluorosis. Chinese Journal of Endemiology. 1985;4(3):242-43.
In Fluoride Action Network. Thyroid [Internet]. Online at http://fluoridealert.org/issues/health/thyroid/. Accessed November 3, 2016.
[92] Hosur MB, Puranik RS, Vanaki S, Puranik SR. Study of thyroid hormones free triiodothyronine (FT3), free thyroxine (FT4) and thyroid stimulating hormone (TSH) in subjects with dental fluorosis. European Journal of Dentistry. 2012 Apr;6(2):184.
And Susheela AK, Bhatnagar M, Vig K, Mondal NK. Excess fluoride ingestion and thyroid hormone derangements in children living in Delhi, India. Fluoride. 2005 May 1;38(2):98-108.
In Fluoride Action Network. Thyroid [Internet]. Online at http://fluoridealert.org/issues/health/thyroid/. Accessed November 3, 2016.
[93] Gas' kov A, Savchenkov MF, Iushkov NN. The specific features of the development of iodine deficiencies in children living under environmental pollution with fluorine compounds. Gigiena i Sanitariia. 2005(6):53.
And Hong F, Cao Y, Yang D, Wangb H. Research on the effects of fluoride on child intellectual development under different environmental conditions. Chinese Primary Health Care. 2001;15(3):56-7.
And Ren D, Li K, Liu D. A study of the intellectual ability of 8-14 year-old children in high fluoride, low iodine areas. Fluoride. 2008 Oct 1;41(4):319-20.
And Wang XH, Wang LF, Hu PY. Effects of high iodine and high fluorine on children's intelligence and thyroid function [J]. Chinese Jouranl of Endemiology. 2001;4:020.
In Fluoride Action Network. Thyroid [Internet]. Online at http://fluoridealert.org/issues/health/thyroid/. Accessed November 3, 2016.
[94] Centers for Disease Control and Prevention. 2014 National Diabetes Statistics Report [Internet]. Page last reviewed October 24, 2014. Page last updated May 15, 2015. Online at http://www.cdc.gov/diabetes/data/statistics/2014statisticsreport.html. Accessed November 3, 2016.
[95] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 260.
[96] Hanhijarvi H. Inorganic plasma fluoride concentrations and its renal excretion in certain physiological and pathological conditions in man. Fluoride. 1975 Jan 1;8(4):198-207.
In Fluoride Action Network. Diabetes [Internet]. Online at http://fluoridealert.org/issues/health/diabetes/. Accessed November 3, 2016.
[97] Marier JR. Some current aspects of environmental fluoride. Science of the Total Environment. 1977 Nov 1;8(3):253-65.
In Fluoride Action Network. Diabetes [Internet]. Online at http://fluoridealert.org/issues/health/diabetes/. Accessed November 3, 2016.
[98] Tokar V, Zyryanova V, Shcherbakov S. Chronic Fluorides Impact on Pancreaic Islet Cells in Workers. Gigiena i Sanitariia (Hygiene and Sanitation). 1992 Nov:42-4.
And Rigalli A, Ballina JC, Roveri E, Puche RC. Inhibitory effect of fluoride on the secretion of insulin. Calcified Tissue International. 1990 May 1;46(5):333-8.
And more in Connett M. Fluoride and insulin [Internet]. Fluoride Action Network. Updated April 2015. Online at http://fluoridealert.org/studies/diabetes02/. Accessed November 3, 2016.
[99] Luke J. Fluoride deposition in the aged human pineal gland. Caries Research. 2001 Mar 9;35(2):125-8.
In Fluoride Action Network. Pineal gland [Internet]. Online at http://fluoridealert.org/issues/health/pineal-gland/. Accessed November 3, 2016.
[100] Luke J. Fluoride deposition in the aged human pineal gland. Caries Research. 2001 Mar 9;35(2):125-8.
And Luke JA. The effect of fluoride on the physiology of the pineal gland [Doctoral dissertation, University of Surrey]. 1997.
And more in Fluoride Action Network. Pineal gland [Internet]. Online at http://fluoridealert.org/issues/health/pineal-gland/. Accessed November 3, 2016.
[101] Kunz D, Schmitz S, Mahlberg R, Mohr A, Stöter C, Wolf KJ, Herrmann WM. A new concept for melatonin deficit: on pineal calcification and melatonin excretion. Neuropsychopharmacology. 1999 Dec 1;21(6):765-72.
In Fluoride Action Network. Pineal gland [Internet]. Online at http://fluoridealert.org/issues/health/pineal-gland/. Accessed November 3, 2016.
[102] Mahlberg R, Kienast T, Hädel S, Heidenreich JO, Schmitz S, Kunz D. Degree of pineal calcification (DOC) is associated with polysomnographic sleep measures in primary insomnia patients. Sleep Medicine. 2009 Apr 30;10(4):439-45.
In Fluoride Action Network. Pineal gland [Internet]. Online at http://fluoridealert.org/issues/health/pineal-gland/. Accessed November 3, 2016.
[103] Farkas G, et al. (1983). The fluoride content of drinking water and menarcheal age. Acta Univ Szeged Acta Biol. 29(1-4):159-168.
And Schlesinger ER, Overton DE, Chase HC, Cantwell KT. Newburgh-Kingston caries-fluorine study X III. Pediatric findings after ten years. The Journal of the American Dental Association. 1956 Mar 31;52(3):296-306.
In Fluoride Action Network. Pineal gland [Internet]. Online at http://fluoridealert.org/issues/health/pineal-gland/. Accessed November 3, 2016.
[104] Freni SC. Exposure to high fluoride concentrations in drinking water is associated with decreased birth rates. Journal of Toxicology and Environmental Health, Part A Current Issues. 1994 May 1;42(1):109-21.
And Hao P, Ma X, Cheng X, Ba Y, Zhu J, Cui L. [Effect of fluoride on human hypothalamus-hypophysis-testis axis hormones]. Wei sheng yan jiu= Journal of hygiene research. 2010 Jan;39(1):53-5.

And more in Fluoride Action Network. Male fertility [Internet]. Online at http://fluoridealert.org/issues/health/fertility/. Accessed November 3, 2016.

[105] Buzalaf CP, de Lima Leite A, Buzalaf MA. Fluoride metabolism. In Fluorine: Chemistry, Analysis, Function and Effects (Edited by Victor R Preedy). 2015 Apr 17 (Chapter 4, pp. 54-72). Page 62.

[106] Buzalaf MA, Whitford GM. Fluoride metabolism. In Fluoride and the Oral Environment 2011 Jun 23 (Vol. 22, pp. 20-36). Karger Publishers.

[107] Fawell JK, Bailey K. Fluoride in drinking-water. World Health Organization; 2006. Page 30. Online at http://www.who.int/water_sanitation_health/publications/fluoride_drinking_water_full.pdf. Accessed November 3, 2016.

[108] Buzalaf CP, de Lima Leite A, Buzalaf MA. Fluoride metabolism. In Fluorine: Chemistry, Analysis, Function and Effects (Edited by Victor R Preedy) 2015 Apr 17 (Chapter 4, pp. 54-72). Page 62.

[109] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 100.

[110] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 280.

[111] Ng AH, Hercz G, Kandel RE, Grynpas MD. Association between fluoride, magnesium, aluminum and bone quality in renal osteodystrophy. Bone. 2004 Jan 31;34(1):216-24.

[112] Fritschi L, Sim MR, Forbes A, Abramson MJ, Benke G, Musk WA, de Klerk NH. Respiratory symptoms and lung-function changes with exposure to five substances in aluminium smelters. International Archives of Occupational and Environmental Health. 2003 Feb 1;76(2):103-10.

And Romundstad P, Andersen A, Haldorsen T. Nonmalignant mortality among workers in six Norwegian aluminum plants. Scandinavian Journal of Work, Environment & Health. 2000 Dec 1:470-5.

And Søyseth V, Kongerud J, Ekstrand J, Boe J. Relation between exposure to fluoride and bronchial responsiveness in aluminium potroom workers with work-related asthma-like symptoms. Thorax. 1994 Oct 1;49(10):984-9.

And Taiwo OA, et al. (2006). Incidence of asthma among aluminum workers. Journal of Occupational and Environmental Medicine 48(3):275-82.

And Viragh E, Viragh H, Laczka J, Coldea V. Health effects of occupational exposure to fluorine and its compounds in a small-scale enterprise. Industrial Health. 2006;44(1):64-8.

And more in Connett M. Respiratory risks from occupational fluoride exposure [Internet]. Fluoride Action Network. 2008. Online at http://fluoridealert.org/studies/respiratory/. Accessed November 4, 2016.

[113] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 92.

[114] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 92.

[115] Fawell JK, Bailey K. Fluoride in drinking-water. World Health Organization; 2006. Page 30. Online at http://www.who.int/water_sanitation_health/publications/fluoride_drinking_water_full.pdf. Accessed November 3, 2016.

[116] Thakre D, Dixit P, Waghmare S, Manwar N, Labhsetwar N, Rayalu SS. Synthesis optimization and fluoride uptake properties of high capacity composite adsorbent for defluoridation of drinking water. Environmental Progress & Sustainable Energy. 2015 Nov 12;34(6):1576-85. Page 1576.

[117] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 293.

[118] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Pages 293-294.

[119] Waldbott GL. Allergic reactions from fluorides. International Archives of Allergy and Immunology. 1958 Jul 1;12(6):347-55.

And Grimbergen GW. A double blind test for determination of intolerance to fluoridated water. Fluoride. 1974 Jul;7(3):146-52.

And more in Fluoride Action Network. Case reports of hypersensitivity to ingested fluorides [Internet]. March 27, 2012. Online at http://fluoridealert.org/studies/hypersensitivity01/. Accessed November 4, 2016.

[120] Shea JJ, Gillespie SM, Waldbott GL. Allergy to fluoride. Annals of Allergy. 1967 Jul;25:388-91.

[121] Brun R. Recurrent benign aphthous stomatitis and fluoride allergy. Dermatology. 2004 Mar 29;208(2):181.

And Camarasa JG, Serra-Baldrich E, Liuch M, Malet A. Contact urticaria from sodium fluoride. Contact Dermatitis. 1993 May 1;28(5):294.

And more in Connett M. Hypersensitive reactions to topical fluorides [Internet]. Fluoride Action Network. March 2012. Online at http://fluoridealert.org/studies/hypersensitivity02/. Accessed November 4, 2016.

[122] Shea JJ, Gillespie SM, Waldbott GL. Allergy to fluoride. Annals of Allergy. 1967 Jul;25:388-91. Online at http://fluoridealert.org/studies/shea-1967/. Accessed March 27, 2017.

[123] Mellette JR, Aeling JL, Nuss DD. Fluoride tooth paste: A cause of perioral dermatitis. Archives of Dermatology. 1976 May 1;112(5):730-1. Online at http://jamanetwork.com/journals/jamadermatology/article-abstract/535898. Accessed March 27, 2017.

[124] Saunders MA. Fluoride toothpastes: A cause of acne-like eruptions. Archives of dermatology. 1975 Jun 1;111(6):793-. Online at http://jamanetwork.com/journals/jamadermatology/article-abstract/535073. Accessed March 27, 2017.

[125] Blasik LG, Spencer SK. Fluoroderma. Archives of Dermatology. 1979 Nov 1;115(11):1334-5. Abstract available at http://jamanetwork.com/journals/jamadermatology/article-abstract/540621. Accessed March 27, 2017.

[126]Pessan JP, Buzalaf MR. Historical and recent biological markers of exposure to fluoride. InFluoride and the Oral Environment 2011 Jun 23 (Vol. 22, pp. 52-65). Karger Publishers. Abstract at https://www.ncbi.nlm.nih.gov/m/pubmed/21701191. Accessed March 27, 2017.

[127] Linhares DP, Garcia PV, Amaral L, Ferreira T, Cury JA, Vieira W, dos Santos Rodrigues A. Sensitivity of two biomarkers for biomonitoring exposure to fluoride in children and women: A study in a volcanic area. Chemosphere. 2016 Jul 31;155:614-20. Abstract at https://www.ncbi.nlm.nih.gov/m/pubmed/27155929. Accessed March 27, 2017.

[128] Buzalaf MA, Massaro CS, Rodrigues MH, Fukushima R, Pessan JP, Whitford GM, Sampaio FC. Validation of fingernail fluoride concentration as a predictor of risk for dental fluorosis. Caries Research. 2012 Jun 12;46(4):394-400. Online at http://www.producao.usp.br/bitstream/handle/BDPI/33522/wos2012-4882.pdf?sequence=1&isAllowed=y. Accessed March 27, 2017.

[129] United States Department of Health, Education, and Welfare. Public Health Service Drinking Water Standards Revised 1962. Washington, D.C.: Public Health Service. 1962. Page 8. Online at https://nepis.epa.gov/Exe/ZyPDF.cgi/2000TP5L.PDF?Dockey=2000TP5L.PDF. Accessed November 2, 2016.

[130] United States Department of Health and Human Services. HHS issues final recommendation for community water fluoridation [Press release]. April 27, 2015. Online at http://www.hhs.gov/about/news/2015/04/27/hhs-issues-final-recommendation-for-community-water-fluoridation.html. Accessed November 2, 2016.

[131] Warren JJ, Levy SM, Broffitt B, Cavanaugh JE, Kanellis MJ, Weber-Gasparoni K. Considerations on optimal fluoride intake using dental fluorosis and dental caries outcomes–a longitudinal study. Journal of Public Health Dentistry. 2009 Mar 1;69(2):111-5. Online at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4350236/. Accessed November 4, 2016.

[132] Warren JJ, Levy SM, Broffitt B, Cavanaugh JE, Kanellis MJ, Weber-Gasparoni K. Considerations on optimal fluoride intake using dental fluorosis and dental caries outcomes–a longitudinal study. Journal of Public Health Dentistry. 2009 Mar 1;69(2):111-5. Online at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4350236/. Accessed November 4, 2016.

[133] Warren JJ, Levy SM, Broffitt B, Cavanaugh JE, Kanellis MJ, Weber-Gasparoni K. Considerations on optimal fluoride intake using dental fluorosis and dental caries outcomes–a longitudinal study. Journal of Public Health Dentistry. 2009 Mar 1;69(2):111-5. Online at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4350236/. Accessed November 4, 2016.

[134] Centers for Disease Control and Prevention. Public Health Service Recommendation [Internet]. Page last reviewed November 3, 2015. Page last updated October 31, 2016. Online at http://www.cdc.gov/fluoridation/faqs/public-service-recommendations.html. Accessed November 22, 2016.

[135] Food and Nutrition Board, Institute of Medicine, National Academies. Dietary Reference Intakes (DRIs): Tolerable Upper Intake Levels, Elements [Internet]. United States Department of Agriculture. Online at https://fnic.nal.usda.gov/sites/fnic.nal.usda.gov/files/uploads/recommended_intakes_individuals.pdf. Accessed November 4, 2016.

[136] Food and Nutrition Board, Institute of Medicine, National Academies. Dietary Reference Intakes (DRIs): Recommended Dietary Allowances and Adequate Intakes [Internet]. United States Department of Agriculture. Online at https://fnic.nal.usda.gov/sites/fnic.nal.usda.gov/files/uploads/recommended_intakes_individuals.pdf. Accessed November 4, 2016.

[137] United States Environmental Protection Agency. Questions and answers on fluoride [Internet]. Online at https://www.epa.gov/sites/production/files/2015-10/documents/2011_fluoride_questionsanswers.pdf. Accessed November 2, 2016.

[138] United States Environmental Protection Agency. Questions and answers on fluoride [Internet]. Online at https://www.epa.gov/sites/production/files/2015-10/documents/2011_fluoride_questionsanswers.pdf. Accessed November 2, 2016.

[139] United States Environmental Protection Agency. Questions and answers on fluoride [Internet]. Online at https://www.epa.gov/sites/production/files/2015-10/documents/2011_fluoride_questionsanswers.pdf. Accessed November 2, 2016.

[140] Brun R. Recurrent benign aphthous stomatitis and fluoride allergy. Dermatology. 2004 Mar 29;208(2):181.
And Camarasa JG, Serra-Baldrich E, Liuch M, Malet A. Contact urticaria from sodium fluoride. Contact Dermatitis. 1993 May 1;28(5):294.
And more in Connett M. Hypersensitive reactions to topical fluorides [Internet]. Fluoride Action Network. March 2012. Online at http://fluoridealert.org/studies/hypersensitivity02/. Accessed November 4, 2016.

[141] Julvez J, Grandjean P. Genetic susceptibility to methylmercury developmental neurotoxicity matters. Frontiers in Genetics. 2013;4. Online at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3861742/. Accessed November 4, 2013.

[142] Mousny M, Banse X, Wise L, Everett ET, Hancock R, Vieth R, Devogelaer JP, Grynpas MD. The genetic influence on bone susceptibility to fluoride. Bone. 2006 Dec 31;39(6):1283-9.

[143] Zhang S, Zhang X, Liu H, Qu W, Guan Z, Zeng Q, Jiang C, Gao H, Zhang C, Lei R, Xia T. Modifying effect of COMT gene polymorphism and a predictive role for proteomics analysis in children's intelligence in endemic fluorosis area in Tianjin, China. Toxicological Sciences. 2015:kfu311.

[144] Hong F, Cao Y, Yang D, Wangb H. Research on the effects of fluoride on child intellectual development under different environmental conditions. Chinese Primary Health Care. 2001;15(3):56-7.
And Vasant RA, VRL NA. A multigrain protein enriched diet mitigates fluoride toxicity. Journal of Food Science and Technology. 2013 Jun 1;50(3):528-34.
And more in Connett M. Nutrient deficiencies enhance fluoride toxicity [Internet]. Fluoride Action Network. March 31, 2012. Updated May 2013. Online at http://fluoridealert.org/studies/nutrition/. Accessed November 4, 2016.

[145] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006.

[146] Fawell JK, Bailey K. Fluoride in drinking-water. World Health Organization; 2006. Page 30. Online at http://www.who.int/water_sanitation_health/publications/fluoride_drinking_water_full.pdf. Accessed November 3, 2016.

[147] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 67.

[148] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 30.

[149] Centers for Disease Control and Prevention. Diabetes latest [Internet]. Page last reviewed and updated on June 17, 2014. Online at http://www.cdc.gov/features/diabetesfactsheet/.
Accessed November 4, 2016.
[151] *With reference to Centers for Disease Control and Prevention material in* Berg J, Gerweck C, Hujoel PP, King R, Krol DM, Kumar J, Levy S, Pollick H, Whitford GM, Strock S, Aravamudhan K. Evidence-based clinical recommendations regarding fluoride intake from reconstituted infant formula and enamel fluorosis: a report of the American Dental Association Council on Scientific Affairs. The Journal of the American Dental Association. 2011 Jan 31;142(1):79-87. Page 85.
[152] Berg J, Gerweck C, Hujoel PP, King R, Krol DM, Kumar J, Levy S, Pollick H, Whitford GM, Strock S, Aravamudhan K. Evidence-based clinical recommendations regarding fluoride intake from reconstituted infant formula and enamel fluorosis: a report of the American Dental Association Council on Scientific Affairs. The Journal of the American Dental Association. 2011 Jan 31;142(1):79-87. Page 85.
[153] Berg J, Gerweck C, Hujoel PP, King R, Krol DM, Kumar J, Levy S, Pollick H, Whitford GM, Strock S, Aravamudhan K. Evidence-based clinical recommendations regarding fluoride intake from reconstituted infant formula and enamel fluorosis: a report of the American Dental Association Council on Scientific Affairs. The Journal of the American Dental Association. 2011 Jan 31;142(1):79-87. Page 85.
[154] Grummer-Strawn LM, Scanlon KS, Fein SB. Infant feeding and feeding transitions during the first year of life. Pediatrics. 2008 Oct 1;122(Supplement 2):S36-42.
In United States Food and Drug Administration. Consumer research on infant formula and infant feeding [Internet]. Page last updated 5/25/2016. Online at http://www.fda.gov/Food/FoodScienceResearch/ConsumerBehaviorResearch/ucm080399.htm. Accessed November 4, 2016.
[155] New fluoride warning for infants. Mothering Magazine. November 2006. Online at http://www.slweb.org/mothering.html. Accessed November 4, 2016.
[156] United States Department of Health and Human Services. Toxicological Profile for Fluorides, Hydrogen Fluoride, and Fluorine. Atlanta, GA: Agency for Toxic Substances and Disease Registry. September 2003. Page 15. Online at http://www.atsdr.cdc.gov/toxprofiles/tp11.pdf. Accessed November 2, 2016.
[157] Singer L, Ophaug RH, Harland BF. Dietary fluoride intake of 15-19-year-old male adults residing in the United States. J Dent Res 1985;64:1302--5.
In Kohn WG, Maas WR, Malvitz DM, Presson SM, Shaddik KK. Recommendations for using fluoride to prevent and control dental caries in the United States. Morbidity and Mortality Weekly Report: Recommendations and Reports. 2001 Aug 17:i-42. Online at https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5014a1.htm. Accessed November 1, 2016.
[158] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 68.
[159] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 68.
[160] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 40.
[161] Goschorska M, Gutowska I, Baranowska-Bosiacka I, Rać ME, Chlubek D. Fluoride Content in Alcoholic Drinks. Biological trace element research. 2016 Jun 1;171(2):468-71. Online at http://link.springer.com/article/10.1007/s12011-015-0519-9. Accessed November 1, 2016.
[162] Warnakulasuriya S, Harris C, Gelbier S, Keating J, Peters T. Fluoride content of alcoholic beverages. Clinica Chimica Acta. 2002 Jun 30;320(1):1-4.
[163] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Pages 65-8.
[164] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006.
[165] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 40.
[166] Erdal S, Buchanan SN. A quantitative look at fluorosis, fluoride exposure, and intake in children using a health risk assessment approach. Environmental Health Perspectives. 2005 Jan 1:111-7.
[167] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 40.
[168] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 37.
[169] Fluegge K. Community water fluoridation predicts increase in age-adjusted incidence and prevalence of diabetes in 22 states from 2005 and 2010. Journal of Water and Health. 2016 May 24:wh2016012. Online at http://jwh.iwaponline.com/content/early/2016/05/24/wh.2016.012. Accessed November 4, 2016.
[170] Xiang Q, Liang Y, Chen B, Chen L. Analysis of children's serum fluoride levels in relation to intelligence scores in a high and low fluoride water village in Chin. Fluoride. 2011 Oct 1;44(4):191-4.
In Connett M. Citizen petition under Toxic Substances Control Act regarding the neurotoxic risks posed by fluoride compounds in drinking water. November 22, 2016. To the United States Department of Environmental Protection (EPA) by the Fluoride Action Network (FAN), the International Academy of Oral Medicine and Toxicology (IAOMT), the American Academy of Environmental Medicine (AAEM), Food & Water Watch (FWW), Moms Against Fluoridation, the Organic Consumers Association, Audrey Adams, Jacqueline Denton, Valerie

Green, Kristin Lavelle, and Brenda Staudenmaier. Online at http://fluoridealert.org/wp-content/uploads/epa-petition.pdf. Accessed March 31, 2017.

[171] Zhang S, Zhang X, Liu H, Qu W, Guan Z, Zeng Q, Jiang C, Gao H, Zhang C, Lei R, Xia T. Modifying effect of COMT gene polymorphism and a predictive role for proteomics analysis in children's intelligence in endemic fluorosis area in Tianjin, China. Toxicological Sciences. 2015:kfu311.
In Connett M. Citizen petition under Toxic Substances Control Act regarding the neurotoxic risks posed by fluoride compounds in drinking water. November 22, 2016. To the United States Department of Environmental Protection (EPA) by the Fluoride Action Network (FAN), the International Academy of Oral Medicine and Toxicology (IAOMT), the American Academy of Environmental Medicine (AAEM), Food & Water Watch (FWW), Moms Against Fluoridation, the Organic Consumers Association, Audrey Adams, Jacqueline Denton, Valerie Green, Kristin Lavelle, and Brenda Staudenmaier. Online at http://fluoridealert.org/wp-content/uploads/epa-petition.pdf. Accessed March 31, 2017.

[172] Peckham S, Lowery D, Spencer S. Are fluoride levels in drinking water associated with hypothyroidism prevalence in England? A large observational study of GP practice data and fluoride levels in drinking water. Journal of Epidemiology and Community Health. 2015 Jul 1;69(7):619-24.
In Connett M. Citizen petition under Toxic Substances Control Act regarding the neurotoxic risks posed by fluoride compounds in drinking water. November 22, 2016. To the United States Department of Environmental Protection (EPA) by the Fluoride Action Network (FAN), the International Academy of Oral Medicine and Toxicology (IAOMT), the American Academy of Environmental Medicine (AAEM), Food & Water Watch (FWW), Moms Against Fluoridation, the Organic Consumers Association, Audrey Adams, Jacqueline Denton, Valerie Green, Kristin Lavelle, and Brenda Staudenmaier. Online at http://fluoridealert.org/wp-content/uploads/epa-petition.pdf. Accessed March 31, 2017.

[173] *See* Connett M. Citizen petition under Toxic Substances Control Act regarding the neurotoxic risks posed by fluoride compounds in drinking water. November 22, 2016. To the United States Department of Environmental Protection (EPA) by the Fluoride Action Network (FAN), the International Academy of Oral Medicine and Toxicology (IAOMT), the American Academy of Environmental Medicine (AAEM), Food & Water Watch (FWW), Moms Against Fluoridation, the Organic Consumers Association, Audrey Adams, Jacqueline Denton, Valerie Green, Kristin Lavelle, and Brenda Staudenmaier. Online at http://fluoridealert.org/wp-content/uploads/epa-petition.pdf. Accessed March 31, 2017.

[174] Schubert J, Riley EJ, Tyler SA. Combined effects in toxicology—a rapid systematic testing procedure: Cadmium, mercury, and lead. Journal of Toxicology and Environmental Health, Part A Current Issues.1978; 4(5-6):764.

[175] Janssen S, Solomon G, Schettler T. Chemical Contaminants and Human Disease: A Summary of Evidence. Supported by the Collaborative on Health and the Environment. 2004. Online at http://www.healthandenvironment.org/docs/CHE_Toxicants_and_Disease_Database.pdf. Accessed November 7, 2016.

[176] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 51.

[177] National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Page 51

[178] Strunecka A, Patocka J. Pharmacological and toxicological effects of aluminofluoride complexes. Fluoride. 1999 Nov 1;32(4):230-42.

[179] Masters R. and Coplan M. Silicofluorides — are associated with an increase in children's absorption of lead. International Journal of Environmental Studies. 1999; 56:435.

[180] Masters RD, Coplan MJ, Hone BT, Dykes JE. Association of Silicofluoride Treated Water with Elevated Blood Lead. Neurotoxicology. 2000; 21(6):1091-1100.

[181] Needleman HL, Gatsonis CA. Low-level lead exposure and the IQ of children. JAMA. 1990; 263(5): 673-678.

[182] Vedantam S. Research links lead exposure, criminal activity [Internet]. The Washington Post. July 8, 2007. Online at http://www.washingtonpost.com/wp-dyn/content/article/2007/07/07/AR2007070701073.html. Accessed November 7, 2016.

[183] Goodwin H. Lead exposure and poisoning in children. Southern California Environmental Report Card. UCLA Institute of the Environment and Sustainability. Spring 2009. Online at http://www.environment.ucla.edu/reportcard/article.asp?parentid=3772. Accessed November 7, 2016.

[184] Masters RD. The social implications of evolutionary psychology: linking brain biochemistry, toxins, and violent crime. In Evolutionary Psychology and Violence: A Primer for Policymakers and Public Policy Advocates. Westwood: Praeger; 2003: 23-56.

[185] Cole G. Fluoride: death of the precautionary principle. (Book chapter that is not yet published.)

[186] *As explained in the Journal of the American Dental Association, "fluoride incorporated during tooth development is insufficient to play a significant role in cavity protection" (Featherstone 2000, at 891). The Centers for Disease Control has confirmed the primacy of fluoride's topical mechanisms, declaring that "fluoride's predominant effect is posteruptive and topical" (CDC 2001, at 4). The NRC has confirmed this as well, stating that "the major anticaries benefit of fluoride is topical and not systemic" (NRC 2006, at 13).*
In Connett M. Citizen petition under Toxic Substances Control Act regarding the neurotoxic risks posed by fluoride compounds in drinking water. November 22, 2016. To the United States Department of Environmental Protection (EPA) by the Fluoride Action Network (FAN), the International Academy of Oral Medicine and Toxicology (IAOMT), the American Academy of Environmental Medicine (AAEM), Food & Water Watch (FWW), Moms Against Fluoridation, the Organic Consumers Association, Audrey Adams, Jacqueline Denton, Valerie Green, Kristin Lavelle, and Brenda Staudenmaier. Online at http://fluoridealert.org/wp-content/uploads/epa-petition.pdf. Accessed March 31, 2017.

[187] *See* Tickner J, Coffin M. What does the precautionary principle mean for evidence-based dentistry? Journal of Evidence Based Dental Practice. 2006 Mar 31;6(1):6-15. Page 11.

[188] *See* Tickner J, Coffin M. What does the precautionary principle mean for evidence-based dentistry? Journal of Evidence Based Dental Practice. 2006 Mar 31;6(1):6-15. Page 11.

[189] Yiamouyiannis JA. Water fluoridation and tooth decay: Results from the 1986-1987 national survey of U. S. school children. Fluoride. 1990 Apr;23(2):55-67.
[190] Peckham S, Awofeso N. Water fluoridation: a critical review of the physiological effects of ingested fluoride as a public health intervention. The Scientific World Journal. 2014 Feb 26;2014. Online at http://downloads.hindawi.com/journals/tswj/2014/293019.pdf. Accessed November 2, 2016.
[191] Tenuta LM, Cury JA. Fluoride: its role in dentistry. Brazilian Oral Research. 2010;24:9-17.
[192] *"In addition, a body of information has developed that indicates the major anticaries benefit of fluoride is topical and not systemic (Zero et al. 1992; Rölla and Ekstrand 1996; Featherstone 1999; Limeback 1999a; Clarkson and McLoughlin 2000; CDC 2001; Fejerskov 2004). Thus, it has been argued that water fluoridation might not be the most effective way to protect the public from dental caries."*
In National Research Council. Fluoride in Drinking Water: A Scientific Review of EPA's Standards. The National Academies Press: Washington, D.C. 2006. Pages 15-16.
See also Kalsbeek H, Kwant GW, Groeneveld A, Backer Dirks O, Van Eck AA, Theuns HM. Caries experience of 15-year-old children in The Netherlands after discontinuation of water fluoridation. Caries Research. 1993 Jul 1;27(3):201-5.
And Seppä L, Kärkkäinen S, Hausen H. Caries Trends 1992–1998 in Two Low–Fluoride Finnish Towns Formerly with and without Fluoridation. Caries research. 2000 Nov 8;34(6):462-8.
[193] Yiamouyiannis JA. Water fluoridation and tooth decay: Results from the 1986-1987 national survey of U. S. school children. Fluoride. 1990 Apr;23(2):55-67.
[194] Peckham S, Awofeso N. Water fluoridation: a critical review of the physiological effects of ingested fluoride as a public health intervention. The Scientific World Journal. 2014 Feb 26;2014. Online at http://downloads.hindawi.com/journals/tswj/2014/293019.pdf. Accessed November 2, 2016.
[195] Heller KE, Eklund SA, Burt BA. Dental caries and dental fluorosis at varying water fluoride concentrations. Journal of Public Health Dentistry. 1997 Sep 1;57(3):136-43.
And Jackson RD, Kelly SA, Katz BP, Hull JR, Stookey GK. Dental fluorosis and caries prevalence in children residing in communities with different levels of fluoride in the water. Journal of public health dentistry. 1995 Mar 1;55(2):79-84.
And Williams JE, Zwemer JD. Community water fluoride levels, preschool dietary patterns, and the occurrence of fluoride enamel opacities. Journal of Public Health Dentistry. 1990 Jun 1;50(4):276-81.
In Connett M. Citizen petition under Toxic Substances Control Act regarding the neurotoxic risks posed by fluoride compounds in drinking water. November 22, 2016. To the United States Department of Environmental Protection (EPA) by the Fluoride Action Network (FAN), the International Academy of Oral Medicine and Toxicology (IAOMT), the American Academy of Environmental Medicine (AAEM), Food & Water Watch (FWW), Moms Against Fluoridation, the Organic Consumers Association, Audrey Adams, Jacqueline Denton, Valerie Green, Kristin Lavelle, and Brenda Staudenmaier. Online at http://fluoridealert.org/wp-content/uploads/epa-petition.pdf. Accessed March 31, 2017.
[196] Fluoride Action Network. Tooth Decay in F vs NF countries [Internet]. Online at http://fluoridealert.org/issues/caries/who-data/. Accessed November 8, 2016.
[197] National Research Council. Health Effects of Ingested Fluoride. The National Academy Press: Washington, D.C. 1993. p. 30.
And European Commission. Critical review of any new evidence on the hazard profile, health effects, and human exposure to fluoride and the fluoridating agents of drinking water. Scientific Committee on Health and Environmental Risks (SCHER). 2011.
See more in Connett M. Fluoride is not an essential ingredient [Internet]. Fluoride Action Network. August 2012. Online at http://fluoridealert.org/studies/essential-nutrient/. Accessed November 1, 2016.
[198] *See Table 2 on page 334 of* Grandjean P, Landrigan PJ. Neurobehavioural effects of developmental toxicity. The Lancet Neurology. 2014 Mar 31;13(3):330-8.
[199] Weyant RJ, Tracy SL, Anselmo TT, Beltrán-Aguilar ED, Donly KJ, Frese WA, Hujoel PP, Iafolla T, Kohn W, Kumar J, Levy SM. Topical fluoride for caries prevention. The Journal of the American Dental Association. 2013 Nov 30;144(11):1279-91. Online at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4581720/. Accessed November 7, 2016.
[200] Centers for Disease Control and Prevention. Community water fluoridation: water fluoridation additives fact sheet [Internet]. Page last reviewed and updated December 22, 2014. Online at http://www.cdc.gov/fluoridation/factsheets/engineering/wfadditives.htm. Accessed November 8, 2016.
[201] Centers for Disease Control and Prevention. Community water fluoridation: water fluoridation additives fact sheet [Internet]. Page last reviewed and updated December 22, 2014. Online at http://www.cdc.gov/fluoridation/factsheets/engineering/wfadditives.htm. Accessed November 8, 2016.
[202]Centers for Disease Control and Prevention. Community water fluoridation: shortages of fluoridation additives [Internet]. Page last reviewed March 23, 2015. Page last updated May 17, 2016. Online at http://www.cdc.gov/fluoridation/engineering/engineering-shortages.htm. Accessed November 8, 2016.
[203] NSW Government Health. Water Fluoridation Q & As [Internet]. NSW Health. November 2015. Page 4. Online at http://www.health.nsw.gov.au/environment/water/Documents/fluoridation-questions-and-answers-nsw.pdf. Accessed November 8, 2016.
[204] Peckham S, Awofeso N. Water fluoridation: a critical review of the physiological effects of ingested fluoride as a public health intervention. The Scientific World Journal. 2014 Feb 26;2014. Online at http://downloads.hindawi.com/journals/tswj/2014/293019.pdf. Accessed November 2, 2016.
[205] Science and Environmental Health Network. Wingspread Conference on the Precautionary Principle. January 26, 1998. Online at http://www.sehn.org/wing.html. November 8, 2016.
[206] Science and Environmental Health Network. Wingspread Conference on the Precautionary Principle. January 26, 1998. Online at http://www.sehn.org/wing.html. Accessed November 8, 2016.

[207] Tickner J, Coffin M. What does the precautionary principle mean for evidence-based dentistry? Journal of Evidence Based Dental Practice. 2006 Mar 31;6(1):6-15. Page 11.
[208] Peckham S, Awofeso N. Water fluoridation: a critical review of the physiological effects of ingested fluoride as a public health intervention. The Scientific World Journal. 2014 Feb 26;2014. Online at http://downloads.hindawi.com/journals/tswj/2014/293019.pdf. Accessed November 2, 2016.
[209] Tiemann M. Fluoride in drinking water: a review of fluoridation and regulation issues. Congressional Research Service Report for Congress. BiblioGov. 2013 Apr 5. Online at https://www.fas.org/sgp/crs/misc/RL33280.pdf. Accessed November 2, 2016.
[210] Peckham S, Awofeso N. Water fluoridation: a critical review of the physiological effects of ingested fluoride as a public health intervention. The Scientific World Journal. 2014 Feb 26;2014. Online at http://downloads.hindawi.com/journals/tswj/2014/293019.pdf. Accessed November 2, 2016.