Stop Fluoridation Now: New Research on Fluoride's Brain and Thyroid Toxicity

by Gary Null, PhD, and Martin Feldman, MD

Several years have passed since we published a three-part article on water fluoridation entitled "The Fluoride Controversy Continues: An Update" in the *Townsend Letter* (see the December 2002, January 2003 and February/March 2003 issues). Since that time, new research has emerged that offers health-care professionals and patients alike a more thorough understanding of fluoride's adverse effects on the body.

In this article, we will look at the effects of fluoride on two vital aspects of the body's functioning – the central nervous system and brain and the thyroid mechanism – in more depth than we did in our prior article. We will also explore a newly emerging area of research, which shows that xylitol, a natural sugar substitute used in chewing gums and other products, provides consumers with an effective alternative to the fluoridation of public water supply systems in preventing dental cavities.

As we reported previously, approximately 162 million Americans on public water systems were receiving fluoridated water in 2000.[1,2] The US government strongly supports water fluoridation on the grounds that it decreases the rate of dental decay.[3,4] Yet studies conducted worldwide have failed to validate this claim. In one large study conducted in 1986/87 for example, there was no statistically significant difference in dental decay rates between fluoridated and nonfluoridated cities.[5] Other research has found a decline in the dental caries rate in countries that do not have fluoridated water.

The research also shows that fluoride can have a wide range of negative health effects. Many of these effects were discussed in our previous article, where readers can find a full investigation of the topic and supporting references from the scientific literature. By way of review, the following list summarizes some of the major effects of fluoride on the body. This accounting should raise serious questions in anyone's mind about the practice of adding fluoride – which, in the case of water fluoridation, is a toxic waste product of the aluminum and fertilizer industries – to community water systems:

- **Dental fluorosis.** The prevalence of dental fluorosis, in which the teeth become permanently stained, brown and mottled due to fluoride exposure, has increased in both fluoridated and nonfluoridated communities in recent decades.[6]
- **Skeletal fluorosis.** Fluoride that is deposited in the bones and teeth can cause this crippling disorder. Some experts have suggested that while skeletal fluorosis is rarely reported in the US medical literature, cases may go unrecognized due to a lack of knowledge about the disorder among physicians.[7]
- **Bone fractures.** Studies have found an association between fluoride and the rate of hip fractures among the elderly.[8-10]
- **Cancer.** Links to fluoridation have been revealed in numerous studies, with one finding that about two-thirds of 36 cancer sites in the body were associated with fluoridated water.[11]
- **Enzyme toxicity and genetic damage.** Even 1 ppm of fluoride – an amount deemed safe for water fluoridation – can interfere with biological functions such as DNA repair enzyme activity and cause genetic and chromosomal damage.[12, 13]
- **Reproductive effects.** Fluoride may have negative effects on the male and female reproductive systems, according to several studies.[14-16]
- **Pineal gland effects.** Fluoride's adverse impact on this gland may interfere with the hormone melatonin, which regulates sleep cycles, the onset of puberty and other functions.[17]
- **Elevated blood lead levels.** Increased levels of lead in the blood of children have been associated with fluoridated drinking water. High levels of lead, in turn, have been linked to certain health disorders and negative behavioral traits.[18, 19]

Brain effects of fluoride

One growing area of research has examined the effects of fluoride on the central nervous system and brain. Recent studies have found that fluoride is a neurotoxin which can affect cerebral functioning, with some research associating the ingestion of fluoridated water with reduced intelligence. Scientific references in this area from human and animal studies deserve careful consideration from physicians and consumers who want to know how the multiple sources of fluoride we are exposed to – fluoridated water, fluoridated toothpaste, fruit juices and soft drinks, infant foods, and others – may affect such a critical aspect of the body's functioning.

A number of studies on the effect of fluoridated water on children's intelligence come from China, where investigators have compared the Intelligence Quotient (IQ) of young people living in high- and low-fluoride areas. These studies include:

- The mean IQ of 222 children, aged 8 to 13 years, in a high-fluoride village was significantly lower (92.02 ± 13.00) than that of 290 children in a low-fluoride village (100.41 ± 13.21). Higher levels of fluoride in drinking water were significantly associated with higher rates of mental retardation (IQ <70) and borderline intelligence (IQ 70-79). The researchers concluded that "drinking water fluoride levels greater than 1.0 mg/L may adversely affect the development of children's intelligence."[20]
- The mean IQ of 60 children, aged 10 to 12 years, in an area with a high level of fluoride in drinking water was significantly lower (92.27 ± 20.45) than that of 58 children in a low-fluoride area (103.05 ± 13.86). The high-fluoride area also had more children (21.6%) in the retardation or borderline categories of IQ than did the low-fluoride area (3.4%).[21]
- Among 907 children, aged 8 to 13 years, there was a 15 to 19 point decrease in IQ in children living in an area with a high fluoride exposure compared with those in an area with little or no exposure. Exposure to a high level of fluoride may affect intelligence at an early, rapid stage of development in the embryo and infant.[22]

In addition to studies on intelligence, other research on humans has associated fluoride with problems in brain functioning. A study of children who grew up in a coal-burning-pattern high-fluoride area in China found that excessive fluoride intake since early childhood would reduce mental work capacity.[23] A study in Mexico found that while children's IQ scores were not influenced by fluoride exposure, other effects on neuropsychological development were associated with chronic exposure (the main source being tap water.) Urinary fluoride correlated positively with an increase in reaction time, which could affect the attention process, and inversely with low scores in visuospatial organization, which could have an impact on the children's reading and writing

abilities.[24] A study of structural fumigation workers found that while occupational exposure to sulfuryl fluoride did not cause any widespread pattern of cognitive deficits, such exposure "may be associated with subclinical effects on the central nervous system, including effects on olfactory and some cognitive functions."[25]

Fluoride's effect on the human brain also extends to the fetus. An examination of 15 therapeutically aborted fetuses in the fifth to eighth month of gestation from a high-fluoride area documented a number of changes in the neurons, undifferentiated neuroblasts and mitochondria. The study concluded that chronic high-fluoride exposure during intrauterine life "may produce certain harmful effects on the developing brain of the fetus."[26]

Another study shows that low concentrations of a variety of salts, including sodium fluoride, significantly reduce the thermodynamic stability of the human prion protein, and thereby may help promote its conversion to a misfolded form of the protein that accumulates in the brain. Prion diseases are fatal neurological disorders that occur in animals and humans. The human versions include Creutzfeld-Jacob disease, Gerstmann-Straussler-Scheinker disease, fatal familial insomnia and kuru.[27]

A number of animal studies also have linked fluoride to neurotoxic effects, such as impaired learning and memory abilities, suppression of spontaneous motor activity and poor performance in motor coordination and maze tests.[28-31] A study by Dr. Phyllis Mullenix and colleagues at Forsyth Dental Center in Boston, published in 1995, evaluated the effects of fluoride on the developing brains of rats, using a computer pattern recognition system to quantify various aspects of the animals' behavior. Prenatal exposure to fluoride was associated with hyperactivity in offspring, and exposure during weaning and adulthood was associated with "cognitive deficits." The severity of the behavioral effects increased directly with plasma fluoride levels and concentrations in specific regions of the brain following fluoride ingestion. The researchers said of their findings: "Of course behaviors *per se* do not extrapolate [across species], but a generic behavioral pattern disruption as found in this rat study can be indicative of a potential for motor dysfunction, IQ deficits and/or learning disabilities in humans."[32,33]

One would expect these findings to spur the US government's interest in the central nervous system effects of fluoride, a substance it promotes as a safe and effective way to prevent dental caries. But that has not been the case, according to Christopher Bryson in *The Fluoride Deception*. Dr. Mullinex presented her results to government scientists and policy makers in a 1990 seminar held at the National Institutes of Health. Fourteen years later, says Bryson, "the NIH still has not funded any examination of fluoride's central-nervous-system effects and, according to one senior official, does not currently regard fluoride and central-nervous-system effects as a research priority."[34]

In a 2004 submission to the National Research Council on fluoride's effect on the brain, Ellen Connett of the Fluoride Action Network notes that Dr. Mullinex's study "has gained support from at least six other rat studies.... While these studies have employed different methods than Mullinex et al. (1995), they are consistent in that they have also found that fluoride impacts behavior and/or learning."[35]

For Dr. Mullinex, says Bryson, the fluoride research seems to have marked the end of her academic career. She was fired from her job at Forsyth Dental Center, where she had been chairwoman of the toxicology department for 11 years, within days of her paper's acceptance for publication. Mullinex says that her dismissal was due to conflict over her decision to publish the findings on fluoride neurotoxicity, according to a report on Salon.com. (One superior has said she was dismissed not because of the fluoride work but because of work-quality problems.)[36,37]

Numerous other animal studies have documented the effects of fluoride toxicity on the brain. To summarize some of this research from the past few years alone, animal studies have found that: fluoride may cross the blood-brain barrier, accumulate in the hippocampus and inhibit the activity of the enzyme cholinesterase[38]; high fluoride intake during the early developing stages of life can cause significant neurodegenerative changes in the hippocampus, amygdala, motor cortex and cerebellum[39]; sodium fluoride can induce DNA damage and apoptosis in the brain[40]; chronic fluoride intoxication during the early stages of life can increase oxidative stress in the brain, disturbing the antioxidant defense system[41]; fluoride inhibits some enzymes involved in free-radical metabolism and membrane functioning in the brain and in muscle[42]; chronic fluoride toxicity reduces the number of neuronal nicotinic acetylcholine receptors (nAChRs), which are involved in cognitive processes such as learning and memory[43]; selective decreases in the number of nAChRs may play an important role in the mechanism(s) by which fluoride causes central nervous system dysfunction;[44] and a high concentration of fluoride and fluoride/iodine combined in drinking water can cause significant changes in the fatty acid composition of brain cells, with a significant decrease in the proportion of unsaturated fatty acid and an obvious increase in saturated fatty acid.[45]

In an editorial in *Fluoride,* Bruce Spittle discusses biochemical studies that have identified mechanisms by which fluoride could affect brain functioning. He summarizes the research as such: Because fluoride can form a strong hydrogen bond with the amide group, the shape of enzymes may be altered and their activity reduced. Aluminofluoride complexes stimulate various guanine nucleotide binding proteins – called G proteins – which may "mimic or potentiate the action of numerous extracellular signals and significantly affect many cellular responses. Fluoride ions in the presence of trace amounts of aluminum are apparently able to act with powerful pharmacological effects."[46]

In one animal study, rats administered aluminum fluoride or sodium fluoride in water had increased levels of aluminum in the brain, neural injury and increased deposits of ß-amyloid protein in the brain. Similar deposits have been associated with Alzheimer's disease, according to a report in *Chemical & Engineering News.* The researchers stated that while the small amount of fluoroaluminum complex needed to produce neurotoxic effects was surprising, "perhaps even more surprising" was the amount of sodium fluoride needed – 2.1 ppm.[47,48] Another set of experiments found that rats given aluminum fluoride or sodium fluoride in drinking water had occlusions in the blood vessels. In the animals administered aluminum fluoride, the occlusions reduced cerebral blood flow and aerobic metabolism. There was a reduced number of cells in two areas of the hippocampus and changes in neurofilaments in the neocortex that are "usually considered to be related to cell dysfunction."[49]

Effects on the thyroid mechanism

The interaction between fluoride and iodine also has been the subject of research, with studies finding effects on both the thyroid system and the brain. The data in this area, on fluoride alone or the fluoride/iodine relationship, include:

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- In a study of 7- to 14-year-olds in China, those in a high-fluoride, low-iodine area had an average IQ of 71, compared with 77 in a normal-fluoride, low-iodine area and 96 in a normal-fluoride, normal-iodine area. Thyroid effects in children in the high-fluoride, low-iodine area included a TSH of 21 mU/ml (compared with 6 in the normal area), a reverse T3 value of 58 ng/dl (21 in the normal area), and a significantly low reverse T3/T3 ratio of 2.91. IQ and TSH were negatively correlated in the study, and 69% of the children with mental retardation had elevated TSH levels.[50]
- An examination of 165 workers in electrolysis shops of aluminum production with signs of fluoride toxicity also had the following thyroid abnormalities: a moderate reduction in the iodine-absorbing function of the thyroid and a low level of T3 hormone with a normal level of T4 hormone.[51]
- A study of 200 children from areas with fluoride in the drinking water found an increase in serum parathyroid levels that was well correlated with fluoride ingestion. An increase in serum parathyroid concentration was associated with a greater severity of clinical and skeletal fluorosis.[52]
- A study of workers continuously exposed to fluorine found that 51% had reduced T3 hormone. An analysis of their immune status showed that the T lymphocyte count rose but that the functional activity of the cells declined, indicating an impaired cooperation of immunocytes due to imperfect control under the low T3 concentrations.[53]
- Research found a higher prevalence of goiter (enlargement of the thyroid gland) in two towns in South Africa with high levels of fluoride in the water.[54]

Among animal studies on this topic, an examination of the long-term effects of various doses of iodine and fluoride on the pathogenesis of goiter in mice found that both an iodine deficiency and an iodine excess could induce goiter and other functional and histopathological changes in the thyroid. Fluorine affected the thyroid changes caused by either iodine status. The researchers concluded that iodine and fluorine have mutually interacting effects on goiter in mice.[55] In a study of pregnant and lactating mice who drank fluoridated water, 14-day-old pups had a 75% decrease in plasma free T4 and reductions of 27% and 17%, respectively, in the cerebellar and cerebral protein concentrations.[56]

Countering fluoride toxicity

Research suggests that a number of natural substances may oppose the adverse effects of fluoride by preventing or treating the toxicity. In his editorial in *Fluoride,* Bruce Spittle notes that dietary factors such as an adequate intake of iodine may protect against high-fluoride effects on the brain and IQ. He adds that while animal studies have found a partial recovery of all parameters studied when sodium fluoride and aluminum chloride are withdrawn, "the administration of ascorbic acid, calcium, or vitamin E, alone or in combination, resulted in a more complete recovery fromm the toxic effects.[57] Recovery was more pronounced with the combination."[58]

Other animal studies have reported similar findings. In one, the effects of sodium fluoride (including locomotor behavioral and dental toxicities) were prevented significantly when the animals received calcium carbonate with the fluoride.[59] In another study, mice receiving a higher concentration of fluoride in drinking water had a remarkable deterioration in learning capability. However, the administration of a proper concentration of selenium with the fluoride could decrease its toxic effects (a concentration of selenium that was too high produced synergistic toxicities). The findings suggested this mineral "might antagonize the neurotoxicity of fluoride on behavior and morphology."[60]

Xylitol: a safe alternative

As research continues to raise questions about fluoride's toxic effects, physicians, dental professionals and consumers may want to seek out other ways to prevent dental decay than by consuming fluoridated water. One alternative with considerable merit is the use of xylitol-containing products. Studies and reviews conducted in the past 10 years have shown that this safe, natural sugar substitute is an effective way to reduce the rate of tooth decay.

Xylitol is a sugar alcohol found in certain forest materials (such as birch and beech hardwoods) and foods (such as berries, plums, mushroom and lettuce). It is also produced by the body from food sources. Manufacturers use xylitol not only to replace sugars in foods (it has long been used as a sugar substitute in the diabetic diet) but also to develop xylitol-containing products for dental use.[61, 62] The latter include products such as xylitol chewing gums, lozenges, candies, and mouthrinses that deliver the anticariogenic substance directly to the mouth.

An explanation of xylitol's mechanisms of action in reducing dental decay, along with other background information, is available on Xylitol.com (a Web site provided by the Finnish company Leaf, which makes xylitol products). In essence, xylitol's anticariogenic effect is based on a biochemical feature of this sugar alcohol: It has five carbon atoms instead of the six carbon atoms found in sweeteners such as sorbitol, fructose and glucose. As a result, the bacteria in the mouth that cause dental cariesi – *streptococcus metans* is the worst offender – cannot ferment xylitol in their metabolism.[63]

When a person consumes xylitol the bacteria do not receive the energy supplied by ordinary sugar (sucrose) that enables them to grow, produce acids and launch an "acid attack." During this attack – which lasts more than a half hour after sugar has been consumed – the pH of plaque formed by the bacteria falls below 5.5. Consequently, calcium and phosphate salts begin to dissolve from the surface of the tooth enamel and cavities slowly begin to form. With xylitol, the pH of saliva and plaque does not fall, acid does not form, the bacteria do not absorb well on the teeth, and the plaque level decreases.[64]

A second anticariogenic effect of xylitol is to stimulate a more alkaline saliva than do other sugar products. This mechanism helps the saliva to correct incipient damage to enamel because the plaque pH may rise above 7 after xylitol products are used. Therefore, the calcium and phosphate salts in the saliva can reach parts of the enamel where they are deficient and the sites begin to harden again.[65]

Research supporting xylitol's effectiveness includes the following:

- A randomized controlled trial of 61 children found a greater shift from higher scores for *streptococcus mutans* (*S. mutans*) to lower scores among subjects who chewed xylitol gum than those in the control group.[66]
- A review of 14 clinical studies published between 1966 and 2001 concluded that the "studies demonstrated a consistent decrease in dental caries, ranging from 30 to 60%, among subjects using sugar substitutes" compared with controls. Subjects using xylitol had the highest reductions in caries.[67]
- A five-year randomized controlled study of 740 10-year-old children found that after three years, the groups using xylitol candies on school days had a highly significant reduction of 35% to 60% in the incidence of caries compared with control groups.[68]

• A randomized controlled trial of 151 subjects found that those who chewed xylitol gum for three months after having used a chlorhexidine (CHX) mouthrinse for 14 days had significantly lower salivary MS levels than did the placebo or control groups. MS levels did not differ significantly at baseline or after the CHX therapy.[69]

• A study of 288 children in a two-year gum-chewing program re-examined them five years later and found that xylitol gum and, to a lesser extent, xylitol/sorbitol gum had a long-term protective effect against caries. During the five years after the gum-chewing program ended, xylitol gums reduced the caries risk 59% and xylitol/sorbitol gums reduced the risk 44%. However, the gum chewing should start at least one year before permanent teeth erupt to maximize the long-term protective effects.[70]

• A two-year study of 169 mother-child pairs found a significant reduction in the probability of transmitting *mutans streptococci* (MS) to children when mothers chewed xylitol gum. Mothers in the xylitol group began chewing the gum three months after delivery, while controls received either chlorhexidine or fluoride varnish treatments at 6, 12 and 18 months after delivery. The children did not chew gum. At 2 years of age, 9.7% of children in the xylitol group (whose mothers began chewing gum three months after delivery) had detectable levels of MS, compared with 28.6% of children in the chlorhexidine group and 48.5% in the fluoride varnish group.[71]

• The Michigan Xylitol Programme, which studied children, adults and geriatric subjects who used saliva stimulants, tested the validity of the "penitol-hexitol theory," which holds that sugar alcohols with five hydroxyl groups (penitols such as xylitol) may be more effective cariologically than sugar alcohols with six hydroxyl groups (hexitols such as sorbitol). The accumulated clinical, sialochemical and microbiologic evidence suggested that xylitol is more effective in preventing caries than sorbitol and is cariologically safer.[72]

• A 40-month double blind cohort study of 1,277 subjects compared the caries rate in groups chewing xylitol, sorbitol or combined gums with a group that received no chewing gum. The gums used in the four xylitol groups were most effective in reducing caries rates. A 100% xylitol pellet gum was the most effective agent.[73]

• Clinical observations from two chewing gum studies found that after 40 months (permanent dentition) or 18 months (primary dentition), an arrest of caries generally occurred more often in children using xylitol or xylitol/sorbitol gums than in subjects who received no gum or used sucrose gum. The findings suggested that "high-xylitol chewing gum usage can retard or arrest even rampant dentine caries in conditions where effective restoration and prevention programmes have not been instituted..."[74]

While some studies have found that xylitol-containing products did not reduce the levels of S. mutans in saliva,[75-77] other studies have confirmed the caries-reducing effects of xylitol and offered insight into its mechanisms of action.[78-86]

In terms of how best to use xylitol, another Web site, Xylitol.org, offers this advice: A person needs to consume 4 to 12 grams a day to prevent tooth decay. Xylitol is safe for everyone at the caries-preventing level of less than 15 grams a day, and higher intakes yield diminishing benefits. Each piece of "all xylitol" mint or gum contains about 1 gram of xylitol, so a person might start by taking one piece four times a day for a total of 4 grams. Xylitol should be used at least three – and preferably five – times a day. In fact, it may not be effective if it is used only occasionally or even once a day. Use the products immediately after eating (swish water in the mouth first), and replace other gums and mints used between meals with xylitol-containing products.[87]

A call to arms

The compelling evidence of fluoride's brain and thyroid toxicity – and its adverse effects on other aspects of health – demands an end to the harmful process of water fluoridation. The good news is that readers who want to oppose the use of fluoride in public water systems will find it easier than ever to research this topic and join other health-minded people in advocating an end to fluoridation.

A wealth of timely information is available via the Internet from groups that are concerned about fluoridation. These coalitions have led a revolution in bringing data on fluoride and the fluoridation process into mainstream society through their Web sites. They provide members and other visitors with the latest research on this topic as it is released, serving as a scientifically sound resource for interested parties. The Web sites also offer guidance on steps individuals can take to oppose fluoridation, such as write letters to local papers and congressional representatives.

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The following two groups, for example, do an excellent job of educating people on the effects of fluoride on humans and the environment:

• **The Fluoride Action Network** (FAN) is an international coalition whose main goals are "to educate the public on the toxicity of fluoride compounds and to end the outdated/hazardous practice of water fluoridation." In addition to providing links to scientific studies, the Web site has a news-tracking page with citations and links for more than 1,200 relevant articles published in the US and worldwide in recent years.

Visit FAN's Web site, www.fluoridealert.org, for information on fluoridation, fluoride pollution, fluorine pesticides, fluoride health effects and much more (802-355-0999). You will also find information on how to become a member of FAN (the basic member rate is $25 a year) and support this group in its opposition of water fluoridation.

• **Second Look** is a national nonprofit initiative that facilitates public and scientific examinations of controversial public policy issues, including fluoridation. The initiative explores the health and environmental effects of fluoridation and its complexity as a social and ethical issue. Among other data, Second Look's Web site includes an extensive bibliography of scientific literature on fluoride that has contributed greatly to this article. US citizens can make tax-deductible donations to this initiative. Go tovwww.slweb.org (508-755-7352).

Other Web sites of interest include the following:

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- Citizens for Safe Drinking Water (www.nofluoride.com)
- Fluoridation.com (www.fluoridation.com)
- Fluoridedebate.com from Health Way House (www.fluoridedebate.com)
- Parents of Fluoride Poisoned Children (www.bruha.com/pfpc/)
- New York State Coalition Opposed to Fluoride (www.orgsites.com/ny/nyscof and www.orgsites.com/ny/nyscof2)
- Massachusetts Communities for Pure Water (www.saveourwater.org)
- Pennsylvania Environmental Network (www.penweb.org/fluoride/)

Another valuable resource is Christopher Bryson's new book, *The Fluoride Deception* (Seven Stories Press, 2004). We recommend this fine scientific book to readers who are intrigued by the puzzle of how a substance as toxic as fluoride ended up in our drinking water and toothpaste in the first place. *The Fluoride Deception* is a fascinating investigation of the politics of water fluoridation and the fraud that led to its use.[88]

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