



Chapter 6: Essay

Water Fluoridation

In the early 1900s, a young dentist, Frederick McKay, opened a dental practice in Colorado Springs, Colorado. He soon discovered that many local residents had brown hole-pocked teeth that, despite being unsightly, had a resistance to cavity formation. Following years of investigation, McKay and his colleagues determined that this condition was caused by unusually high levels of naturally occurring calcium fluoride in the drinking water. The condition became known as dental fluorosis. By the 1930s, the U.S. Public Health Service began to study the idea of



Figure A

What are the pros and cons of adding fluoride ions to drinking water?

The first municipal fluoridation test programs began in the 1940s, soon after World War II, which was a time when the general public held great trust in the chemical industry as well as government. In Grand Rapids, Michigan, for example, sodium

fluoride, once widely regarded as rat poison, was to be added to the municipal drinking water for 15 years, after which time the program would be evaluated for effectiveness. Also, the upstate New York towns of Newburgh and Kingston, which had similar demographic and water profiles, were chosen for a double study in which the water of only one town (Newburgh) would be fluoridated. After 10 years, the rates of dental decay in each city would be compared. Halfway through the Newburgh/Kingston trial, however, the U.S. Public Health Service announced a preliminary 65 percent decrease in dental decay in Newburgh. Word of this and other trials quickly spread, and soon many municipalities were requesting water fluoridation, well before any of these initial trials could be completed.

As can be expected, there were many who advocated against the fluoridation of public drinking water. They argued that fluoride is not a natural nutrient, but a drug and industrial pollutant, and that fluoridation is unethical because individuals are not being asked for their informed consent prior to being given medication. As any physician knows, what is good for one patient is not necessarily good for another patient. A counterargument to this was that fluoridation of public water provides a benefit to the whole community, including the underprivileged, and not just those who can afford good health care. Opponents to fluoridation, however, also pointed out that the long-term side effects of fluoride were not known. Of particular concern were the risks of skeletal fluorosis, bone cancer, and hypothyroidism. Believing these risks to be minimal compared to the great dental benefits, the government, motivated in large part by professional dental associations, continued to push



for fluoridation. Today, about 145 million people in the United States regularly drink fluoridated water. As a quick Internet search reveals, the fluoridation debate continues to be most vigorous. For example, the American Dental Association, www.ada.org, publishes a well-known booklet that clearly advocates the great benefits and minimal risks of fluoridating municipal drinking water. This is countered by a review article published by the National Center for Biotechnology Information (NCBI) and entitled: "[The Fluoride Debate: The Pros and Cons of Fluoridation](#)." Of note is the fact that drinking water in most of Europe is no longer fluoridated. Most European nations, as well as Japan, halted water fluoridation in the 1970s, after which their rates of dental caries continued to decline, as within the United States. Furthermore, the U.S. Centers for Disease Control and Prevention have noted the lack of evidence supporting the effectiveness of ingested fluoride. Rather, teeth appear to benefit by surface exposure, as occurs when the teeth are brushed with fluoridated toothpaste.



Figure B

Evidences suggests that small amounts of fluoride help growing children to become resistant to tooth decay. Should this fluoride be ingested through public drinking water?

In 1987, the U.S. government– sponsored National Institute of Dental Research (NIDR) examined the teeth of about 39,000 school- children aged 5 to 17 from 84 geographical areas, with and

without fluoridated water. Analysis of this data by John Yiamouyiannis, a biochemist and ardent opponent of fluoridation, showed no meaningful statistical differences between children growing up in fluoridated and non-fluoridated areas, except that 5- to 6-year-olds drinking fluoridated water tended to keep their baby teeth longer. Analysis by the NIDR of the same data indicated that children who have always lived in fluoridated areas have 18 percent fewer decayed surfaces than those who have never lived in fluoridated areas.

As the debate continues, one thing remains certain: those who are familiar with the basic concepts of chemistry and methodologies of science are at a great advantage for understanding the issues and for being able to recognize well- informed arguments and decisions.

CONCEPT CHECK

Teflon® is a carbon-based molecule with lots of fluorine. Might flossing with Teflon®-coated dental floss be a good way of introducing additional fluoride to your teeth?

CHECK YOUR ANSWER The fluoride ion is indicated to help prevent dental decay. Sources of these ions include the ionic compounds sodium fluoride, NaF, and stannous fluoride, SnF₂. The fluorine within Teflon® is not ionic. Rather, Teflon® as a molecule (covalent compound) contains fluorine atoms covalently bound to the carbon atoms. There are no fluoride ions in Teflon. These fluorine atoms cannot escape the molecule to join the structure of tooth enamel.

Think and Discuss

1. In 1962, the Kettering Laboratory of the University of Cincinnati conducted a study in which dogs were exposed to calcium fluoride dust at a rate simulating human occupational exposure. The results of the study showed significant damage to the dogs' lungs and lymph nodes. This study was funded by an industry group that was seeking evidence to help counter worker claims of crippling skeletal fluorosis.



Consequently, the study remained unpublished. Should there be laws that prohibit the suppression of unfavorable research data? Try answering this question from the point of view of a company that might have contributed millions of dollars to the research.

2. What kind of pressures might a scientist face if she discovered evidence suggesting that fluoridated water had neurotoxic effects in rats? Assume she works for the government, for a government-funded university, for a private research firm not related to dental health, or for a professional dental association.

3. The most common form of fluoride added to municipal drinking water today is hydrofluosilicic acid, H_2SiF_6 , which is obtained from the antipollution smokestack scrubbers of the phosphate fertilizer industry. What are the advantages and disadvantages of this system? If water fluoridation were banned, what might become of this hydrofluosilicic acid?

4. How could the Newburgh/ Kingston trials have been designed to ensure that the results were not affected by the bias of pro-fluoridation dentists and government officials? Were government officials justified when they published the preliminary results?

5. Vitamin B12 deficiency affects about one-quarter of the U.S. population and is more common in the elderly. This deficiency is often undetected and can lead to devastating and irreversible complications. Should vitamin B12 be added to municipal drinking water? Why or why not?

6. A town claims that over the course of 10 years, it'll save at least \$5 million and at most \$32 million by not fluoridating its water. How might this town use this saved money to help protect the dental health of all its citizens, including children of under-employed families? Should the saved money instead be returned to the citizens in the form of lower taxes?

7. In many countries lacking elaborate waterworks systems, fluoride is provided to the general population by adding it to commercial table salt. What might be some of the advantages and disadvantages of this sort of fluoride delivery system?

8. People have been told that the fluoride in their drinking water helps to protect their teeth. To what extent does this prompt them to ignore good dental health habits such as eating healthfully, avoiding sweets, and brushing and flossing regularly?

9. Studies indicate that males exposed to fluoridated drinking water throughout their childhood experience a drop in their intelligence by 3 to 4 IQ points. If this is the case, who should be liable?



Author Responses to Think and Discuss

1. As of the writing of this edition, there are still no laws governing the suppression of privately funded unfavorable research results.

2. This discussion question reflects the real-life case of Phyllis Mullenix, a neurotoxicologist hired by the Forsyth Dental Center in Boston. Mullenix's research

showed that, with chronic exposure, fluoride ions could cross the blood-brain barrier and serve as a neurotoxin in rats. She was told not to publish for fear that Forsyth would lose funding from the NIDR. She published anyway within *Neurotoxicology & Teratology*, and within a few days her contract with Forsyth was not renewed.



3. Initially, the aluminum industry was the leading fluoride polluter turned municipal fluoride provider. With the downturn of domestic aluminum production, however, the phosphate fertilizer industry became the leading fluoride provider. Phosphate rock is treated with sulfuric acid, which reacts with the fluorite impurities of the phosphate rock to produce silicon tetrafluoride, SiF_4 , and hydrogen fluoride, HF . These volatile fluoride compounds are sequestered in the scrubber as they react with water to form hydrofluosilicic acid, H_2SiF_6 , also known as fluorosilicic acid or fluosilicic acid. This is a highly corrosive acid that is delivered typically as a 23% aqueous solution. Because it comes as a liquid it is easier to add to water than crystalline sodium fluoride and fluorosilicate. The average cost for a year supply of hydrofluosilicic acid is about 15 cents per person. Trace amounts of cadmium, lead, arsenic, and other heavy metals are usually found within this industrial grade hydrofluosilicic acid, but their concentrations are determined to be negligible.

4. The general consensus among fluoridation opponents is that these early trials were seriously flawed by the bias of both the dentists and government officials involved. One possible way of improving the reliability of the results would have been to upgrade the experiment from a double study to a double-blind study where neither the dentists nor the government officials would know which of the two cities was being fluoridated. However, what would prevent an overly-enthusiastic administrator from secretly analyzing the tap water for its fluoride content? The government officials were about to lose their jobs with the end of the Truman presidency. Little wonder that they were tempted to announce positive results only halfway through the trial.

5. Sources of fluoride are cheap and abundant. Not so with vitamin B-12. Furthermore, vitamin B-12 is a reactive organic molecule that would not well survive the trip from the water treatment plant to the faucet, especially with chlorinated water. These technical problems aside, would it be ethical to enforce vitamin B-12 supplements on everyone? It is interesting how different the public attitudes and perceptions were back in the 1940s and 1950s. These were the pre-Rachael Carlson

times; the times when plastics were considered the wonder material, when DDT was the wonder pesticide, and few were aware of the problems of lead-based paints and gasoline. It is from this very era that municipalities embraced the addition of fluoride, a known toxin, to their drinking water.

6. This money could be used to provide all children with dental sealants, which are far more effective at preventing tooth decay than water fluoridation. Good dental health also comes from a healthy diet consisting of many fruits and vegetables. This money, therefore, could be used to help promote healthy diets. Alternatively, where do we draw the line when it comes to decisions regarding personal health? Some would rather it was not dictated by governmental agencies. Others point out that governmental agencies are very effective at programs designed to inform the general public.

7. Most people salt their food, so most people would have access to fluoride ions. This would be similar to how iodide ions are added to commercial salt to protect the population against goiter. Because of different geologies, the waters of some regions have naturally higher fluoride levels than others. Without a waterworks system, people get their water from their immediate environment. People drinking water that is naturally high in fluoride will need to avoid the fluoridated salt. Regulating how much fluoridated salt each community should receive would be difficult. Also, many people are told to avoid salt because of high blood pressure. Encouraging these people to eat a lot of salt to protect their teeth, therefore, could cause more harm than good.

8. The extent will vary. What everyone should understand is that one cannot rely solely on the fluoride in drinking water to protect teeth from cavities. For good dental health, eating healthy, avoiding sweets, and brushing and flossing regularly are essential.

9. To learn more, search Google Scholar for fluoride as a neurotoxin. Here's a link to a news article concerning this issue: <https://www.cnn.com/2019/08/19/health/fluoride-neurotoxin-canada-study/index.html>

