

**The Truth about Fluoride. Science versus Politics.
By Paul Connett, PhD**



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Paul Connett is a graduate of Cambridge University and holds a PhD in chemistry from Dartmouth College. From 1983 until he retired in May 2006, Paul taught chemistry at St. Lawrence University in Canton, NY, where he specialized in Environmental Chemistry and Toxicology. Over the past 40 years his research on waste management has taken him to 49 states in the U.S., 7 provinces in Canada and 70 other countries.

Paul Connett has researched the literature on fluoride's toxicity and the fluoridation debate for 30 years. In 2000 he helped found the Fluoride Action Network (FAN) for which he was the executive director for many years (he stepped down in early 2022). He has given invited presentations on the dangers of fluoridation in many countries. In 2003, he was the only opponent of fluoridation to be invited to present his views to a panel of the U.S. National Research Council of the National Academies in its review of the toxicology of fluoride (NRC 2006).

In 2010, with two other authors (James Beck MD, PhD and Spedding Micklem DPhil) he published **"The Case Against Fluoride"** (Chelsea Green), which contains 80 pages of citations to the scientific literature.

Chapter content

1. Introduction
2. Biochemical activity of fluoride
3. Ethical arguments against water fluoridation
4. The science on benefits including the Catfish and Lotus Studies
5. The science on risks
6. Current U.S. law does not protect citizens from fluoride
7. Damage to the brain
8. No governmental warnings
9. The NTP's systematic review of fluoride's neurotoxicity
10. The TSCA petition and lawsuit against the U.S. EPA
11. Enter the politics: The unprofessional attack on Christine Till
12. FOIA Requests reveal pressures to prevent release of the NTP report
13. Judge demands that NTP report be made available to the court
14. Key Findings in the NTP's State of the Science monograph (May 18 2022, released March 15, 2023)
15. The Spanish study
16. Grandjean's Benchmark Dose (BMD) analysis, 2023
17. More Politics: pro-fluoridation governments continue to push for more fluoridation
18. TSCA trial part 2, February 2024
19. Conclusions

Synopsis

Water Fluoridation is the deliberate addition of a fluoridating chemical (a substance which yields fluoride ions when dissolved in water) into the public water supply ostensibly to fight tooth decay. The author, explains why this is reckless thing to do.

The practice was endorsed by the U.S. Public Health Service in 1950 before any trials had been completed and before any serious studies of health effects had been published. Only about 4% of the world's population have adopted this controversial practice and most of these live in North America.

Until recently studies on the health risks posed by fluoride have largely emerged from countries like India and China which have large areas with naturally high levels of fluoride (endemic fluorosis areas) in their drinking water. Since the 1980s a growing number of these studies have shown that fluoride lowers IQ. Between 2017 and 2020 U.S. government-funded studies have shown a lowering of IQ in Canada and Mexico at fluoride levels experienced in artificially fluoridated communities.

Since 2016 the U.S. National Toxicology Program (NTP) has been reviewing the neurotoxicity of fluoride. Two draft reviews were made public in 2019 and 2020 but the final NTP Review completed in May 2022 was withheld by order of the deputy director of the National Institutes of Health. This NTP review has become a key document in a Federal Court case in which citizens' groups have sued the U.S. Environmental Protection Agency (EPA) to ban the deliberate addition of fluoride to drinking water. On Dec 24, 2025, the judge in this federal trial ruled that water fluoridation posed an "unreasonable risk" to the health of children with respect to its impact on the developing brain.

Objectives

To summarize both the ethical and scientific arguments against the practice of water fluoridation. Special attention will be given to the issue of fluoride's impact on the developing brain. Attention will also be drawn to the ways that powerful government agencies have used their influence for many decades to win the debate politically rather than defend the practice scientifically.

Key points

- 1) The fluoride ion is toxic to many species, including humans.
- 2) Mothers' milk contains very little fluoride (less than 0.01 ppm) and as such protects the nursing infant from fluoride. However, bottle feeding infants with formula made up with fluoridated water removes that protection.
- 3) Fluoride can cross the placenta. During pregnancy, there is no protection to the fetus from the fluoride that the mother is exposed to.
- 4) Fluoride poses a risk to both the fetal and infant brain.
- 5) There have been over 70 human studies indicating that fluoride can lower the IQ of infants and children. These include U.S. government-funded Mother-Child cohort studies.

- 6) Pro-fluoridation government agencies (both state and federal) continue to exert political pressure to further propagate water fluoridation.
- 7) A U.S. Federal Court Case brought by citizens' groups has offered a level playing field for fluoride's neurotoxicity to be judged on its scientific merits.
- 8) In December 2024, the court ruled that fluoridation posed an 'unreasonable risk' to the developing brains of children.

1. Introduction

- 1.1** This chapter sets out to update a book co-authored by the author: *The Case Against Fluoride*¹ and particularly the evidence that even at low levels fluoride can damage the developing brain.
- 1.2** The author has been an outspoken opponent of the practice of water fluoridation for many years. However, his opposition (along with that of his colleagues at the Fluoride Action Network, the group he helped to found in 2000) has been firmly grounded on a science-based examination of the literature. He did not arrive at his position lightly.
- 1.3** Indeed, when his wife first brought her concerns to him about the practice in July 1996, he wanted nothing to do with the issue. Like so many professionals he had been intimidated by the prevailing characterization of opponents of this practice as "crazy." However, when he read the material that his wife had assembled he was dismayed by his prior gullibility. With his eyes opened he was appalled by the recklessness of governments deliberately exposing human beings to a highly toxic substance via the water supply.
- 1.4** As a professor of chemistry, specializing in environmental chemistry and toxicology, he had believed that opponents of fluoridation had confused the element fluorine (the most reactive element known) with the compound fluoride. They had not.
- 1.5** In chemistry one of the first things we learn is that when elements combine to form compounds their properties dramatically change. For example, when the element sodium (a very reactive metal) combines with the element chlorine (a poisonous gas) the compound formed is sodium chloride or common salt which is safe enough to use in cooking. One might ask, wouldn't the fluoride formed from fluorine be equally benign? Unfortunately, the answer is no. The fluoride ion, while being unreactive from a chemical point of view, is highly active biochemically. And that is where this largely scientific review will begin.

2. The biochemical activity of fluoride

- 2.1** The earliest opponents of fluoridation in the 1950s were biochemists. Many of them had used fluoride in their experiments to inhibit enzymes. These included

James Sumner, who shared the Nobel prize in chemistry in 1946 for his work on enzyme chemistry. Fluoride interferes with the function of many enzymes. Enzymes are proteins which facilitate (catalyze) nearly every chemical reaction in the human body.

2.2 The fluoride ion or F^- is a small negatively charged ion. It is attracted to positive centers including metal ions. Many enzymes have metal ions (e.g. Zn^{2+} and Cu^{2+}) located in their active centers.

2.3 Fluoride ions also interfere with the important metal ion Ca^{2+} , which has many functions in the body, including the mechanism of carrying nerve signals across the synapse (the junction between adjacent nerve cells).

2.4 Fluoride also enhances the toxicity of the metal ion Al^{3+} by forming the complex AlF_4^- . This complex ion is the same size and shape as the extremely important phosphate ion (PO_4^{3-}).

2.5 The fluoride ion also forms a strong hydrogen bond.² This is serious because hydrogen bonds underpin the structure and function of both proteins and nucleic acids like DNA. The breaking and making of hydrogen bonds are involved in critical catalytic processes facilitated by enzymes.

2.6 More details on the biochemistry of fluoride are provided in an excellent review by Barbier et al.³

2.7 Fluoride is the thirteenth most abundant element in the earth's crust, but unfortunately that does not make it safe. The appearance of elements in the earth's crust is a function of geology not biology. "Nature" has had to deal with whatever elements and compounds geology dished up in the rocks and the sea where life emerged.

2.8 Nature's response to the matter of fluoride's toxicity is most revealing. Defense mechanisms have evolved in evolution's earliest creatures. Thanks to the research of Ron Breaker and colleagues at Yale,⁴ we now know that bacteria and fungi and some plants have genes which code for proteins which pump excess fluoride ions out of their cells. These are known as fluoride-exporting proteins or FEX proteins.⁵

2.9 We are not sure if such proteins exist in mammals but by the time evolution had reached species like mammals (Including humans) they were equipped with **kidneys** which are capable of excreting about 50% of all the fluoride ingested each day. Children can excrete less with their rapidly growing bones holding onto as much as 80% of the fluoride ingested.

2.10 After passage through the kidney our **bones** take up (sequester) most of the

remaining fluoride as it circulates in the blood. This maybe a mixed blessing. On the one hand the sequestration keeps most of the toxic fluoride ions away from our vulnerable soft tissues, on the other hand the accumulation of fluoride in our bones has lifetime consequences.

2.11 The first symptoms of fluoride's poisoning of the bone (skeletal fluorosis) which is common in some areas of the world (e.g. parts of India, China and Africa) with high natural levels of fluoride in their water, are similar to the early symptoms of **arthritis**. These areas are often referred to as "endemic fluorosis" regions. As more fluoride accumulates it makes the bones more brittle making the elderly more vulnerable to **hip fractures** as demonstrated in a recent high-quality epidemiological study⁶ (discussed further in section 5).

2.12 Nature further protects infants by keeping the fluoride levels in human breast milk very low. The average level is around 0.01 ppm and as low as 0.004 ppm.⁷ This means that a baby which is fed formula made up with fluoridated tap water (at 0.7 ppm) gets 70 to over 100 times higher dose than *a breast-fed baby*. In other words, ***a breast-fed baby is protected from fluoride but water fluoridation removes that protection.***

2.13 Unfortunately, the fetus is not protected from fluoride because the ***fluoride ion can cross the placenta***. The consequence of this will be discussed in more detail in section 7, which deals with fluoride and the brain.

2.14 It is also revealing that nature appears to have found ***no single use for fluoride in any internal tissue***. The single benefit of fluoride appears to be largely restricted to its topical interaction with the tooth enamel after the teeth have erupted (CDC,1999).⁸

2.15 **SUMMARY:** the practice of water fluoridation exposes human beings, from conception to the end of life, to a highly toxic substance that interferes with fundamental aspects of biochemistry and offers no known internal benefits to any tissue, only a topical interaction with the surface of the tooth.

3. The ethical arguments against water fluoridation

3.1 Fluoridation began in 1945 with early trials in the U.S. and Canada and it was endorsed by the U.S. Public Health Service in 1950.¹ Perhaps the most important ethical argument, and certainly the one that underpins most citizens' opposition, is that no government (local, state or federal) has the right to force the individual to take into his or her body a medicine without their informed consent.

3.2 In essence, water fluoridation allows the community to do to *everyone* what an individual doctor can do to *no one*, i.e. force a patient to take a particular medicine.

3.3 Once fluoride is added to the water there is no way to control the **dose** that individuals receive, because a) people drink different amounts of water and b) there are many other sources of fluoride in their daily lives including dental products, pesticide residues, tea, and foods which have high natural levels of fluoride (animal and fish bones).

3.4 Moreover, once fluoride is added to the water, there is no control of who gets the medicine: **it goes to everyone regardless of their age, their health or nutritional status.**

3.5 No health agency or medical personnel is charged with overseeing the patient's response to this medical practice.

3.6 Individuals that do not want to drink fluoridated water -especially those of low income- have little or no option to opt out of the measure.

3.7 In an excellent review⁹ of the subject, professor Rita Barnett-Rose, *writes*:

While the public health objective of preventing childhood tooth decay is laudable, the means to achieve it has caused considerable acrimony between opposing viewpoints, with little room for consensus or conciliation due to the all-or-nothing nature of the coercive measure. Public health officials should therefore consider whether there is a less intrusive intervention that would achieve the public health goal without invading the bodily integrity rights of the many who find the measure objectionable on health, ethical, and/or legal grounds.⁹

3.8 An alternative is presented in the next **section**.

4. Science on benefits including the recent Catfish and Lotus studies

4.1 Considering the serious ethical arguments discussed in section 3, it is surprising that any government or health agency would have embarked on such a practice without having overwhelming scientific evidence that the practice was both effective (at significantly reducing tooth decay) and safe for all, including the fetus, the very young and the very old.

4.2 Incredibly, other than stating again and again in public that the practice is **“safe and effective”** no government in the few countries that have adopted this practice (largely the English-speaking countries Australia, Canada, Ireland, N.Z., U.K. and the U.S.) have produced sound and convincing scientific evidence that it is either. They have frequently used the fallacy that ***the absence of study is the same as the absence of harm.***

4.3 The evidence on effectiveness will be discussed in this section and the safety will be discussed in sections 5 and throughout the rest of the chapter,

4.4 The author and his colleagues summarized in some detail the very weak evidence that swallowing fluoride (as opposed to topical applications) actually lowers tooth decay in chapters 7 and 8 in the book they co-authored.¹

4.5 Studies and key reviews that have appeared since our book was published in 2010, confirm how elusive finding convincing evidence of any meaningful benefit continues to be. Here are some of them.

4.6 **In 2015 the Cochrane collaboration**¹⁰ (considered to be the gold standard for evaluating the efficacy of medical treatments) reviewed the effectiveness of swallowing fluoride for fighting tooth decay. They could find no high-quality studies (i.e. **no Randomized Clinical Trials (RCT)**) to support many of the claims made by promoters for fluoride's benefits.

4.7 Specifically, the Cochrane Review found no high-quality studies that supported the frequent claims that 1) water fluoridation is of benefit to adults, nor that 2) it reduced social inequalities with respect to tooth decay in children, nor that 3) it provides additional benefits over and above topically applied fluoride (such as in toothpaste), nor that 4) tooth decay increases in communities when fluoridation is stopped.

4.8 As far as studies that showed a small reduction in tooth decay in children, the Cochrane collaboration was not convinced that these early studies were applicable to today's society as nearly all the studies used in calculations (dating back to the 1940's) were conducted prior to the availability of fluoride toothpaste. Moreover, they concluded that these early studies had a high risk of bias.

4.9 In sharp contrast to this less than convincing evidence that swallowing fluoride lowers tooth decay there have been many RCTs analyzed by Cochrane which found a lowering of tooth decay associated with use of fluoridated toothpaste.¹¹

4.10 The Catfish Study, 2022.¹² The Catfish study was a UK government-funded study set up to evaluate a water fluoridation scheme in Cumbria, England. It was a longitudinal cohort study. The authors undertook the study "to see if water fluoridation, reintroduced in 2013, was still useful in reducing tooth decay and if it represented good value for money." They "compared levels of decay in children living in areas with fluoridated water and in children living in areas without fluoridated water."

4.11 They "recruited a group of children at birth from September 2014 to September 2015 (referred to as the birth cohort). In addition, a second group of

children, turning 5 years old in 2013–14, were recruited from primary schools (referred to as an older school cohort).

4.12 The authors “followed the birth cohort until age 5 years and followed the older school cohort until age 11 years, and measured whether or not the younger children had any obvious dental decay in their baby (milk) teeth and the older children had decay in their permanent (adult) teeth.”

4.13 The authors concluded:

- WF [water fluoridation] has a small beneficial impact on preventing caries in the primary dentition, but this is much smaller than the effect size reported by the York and Cochrane reviews... This reduction in effectiveness is likely to be due to the low caries prevalence seen following the widespread use of fluoride toothpaste.
- The benefit did not translate to a significant reduction in extractions undertaken in hospital or self-reported dental health outcomes for either cohort.
- There was insufficient evidence of a benefit in the older school cohort for the permanent dentition when considering the proportion of children developing caries. Although there was a statistically significant difference in DMFT [Decayed, Missing and Filled Teeth] (note: dmft refers to primary teeth) the magnitude of difference was small.

4.14 **The Lotus study, 2024.** The Lotus study¹³ was a second and larger UK-government funded study. It was a well-designed 10-year retrospective cohort study. Using NHS (National Health Service) dental treatment records, it reviewed tooth decay in over 6 million patients across the UK.

4.16 According to the authors the objective of the study was “To pragmatically assess the clinical and cost-effectiveness of water fluoridation for preventing dental treatment and improving oral health in a contemporary population of adults and adolescents...”

4.17 **The benefits found were very modest.** The authors summarized their findings:

The “Predicted mean number of invasive NHS dental treatments (restorations ‘fillings’/extractions) was 3% lower in the optimally fluoridated group (5.4) than the non-optimally fluoridated group (5.6). Predicted mean DMFT was 2% lower in the optimally fluoridated group... There was no difference in the predicted mean number of missing teeth per person and no compelling evidence that water fluoridation reduced social inequalities in dental health.

4.18 **Benefits may not be meaningful.** The authors concluded that “Receipt of optimal water fluoridation 2010–2020 resulted in very small positive health effects which may not be meaningful for individuals.”

4.19 **Historical perspective.** To put the results of the Lotus study into historical context, when fluoridation began in the USA in the 1950s promoters claimed a reduction in tooth decay of over 60%. By the 1990s the CDC was claiming a reduction of 25%. The Lotus study found only a meager 2-3% reduction.

4.20 **Risks versus benefits.** The Catfish study authors advised that “it is essential that an assessment of **fluorosis** is undertaken to enable the very modest benefits... be placed into context...providing policy-makers with all the information required to inform decision-making.” ***Please note that dental fluorosis is the only side effect of fluoridation ever admitted by fluoridation promoters.***

4.21 This author would go further. With reference to the rest of this chapter, policy-makers need to put these “very modest benefits” into the context, not just of dental fluorosis, but ***to the threat that fluoride poses to the developing brain (see section 7).***

4.22 It is important to remind readers that the vast majority of countries do not fluoridate their water, including 97% of European countries. Most encourage the more rational delivery system of fluoridated toothpaste.

4.23 **An alternative strategy.** Scotland does not practice water fluoridation, instead, the Scottish health authorities have initiated the Childsmile program.¹⁴ In this program children are taught to brush their teeth in school from the earliest age. They and their parents are also given advice on healthy snacks and drinks which provide more nutrients and less sugar. This program is highly cost effective and has achieved a greater overall reduction in tooth decay compared to fluoridated New Zealand.

4.24 **SUMMARY:** The benefit of high concentration fluoride topical applications does not seem in doubt, however a clear demonstration that swallowing fluoride lowers tooth decay remains elusive. Recent government funded studies in the UK could find only a very modest saving of 2-3% in tooth decay, which could hardly justify the risk of dental fluorosis, let alone damage to the developing brain. Fortunately, alternative strategies are available as demonstrated in Scotland and other European countries, most of which do not practice water fluoridation.

5. Science on fluoride’s risks, including the 2006 NRC Review

5.1 In 2003, the EPA asked the National Research Council of the Academy of Sciences (NRC) to review their standards for fluoride. In 2006, the NRC published its landmark review of the toxicology of fluoride in drinking water.⁷ This review offers a very good place for independent observers to get a more objective view of the health risks posed by fluoride and fluoridation.

5.2 This review was unlike any previous official reviews. Most importantly, those who made the selection of panelists did their best to get a balanced panel. The panel of 12 included three scientists known to be pro-fluoridation, three opposed and six who had taken no public position.

5.3 The panel did a very thorough and comprehensive job, looking at a whole range of toxicological studies including animal and biochemical studies, clinical trials, model systems and epidemiological studies. As a result, a report that was expected to take one year, ended up taking three.

5.4 The final report was approximately 500 pages in length and is a veritable textbook on the toxicology of fluoride. The significance of the NRC report is discussed in more detail in chapter 14 of our book and was used as the starting point for examining impacts on several tissues, see chapters 15-19.¹

5.5 Fluoride impacts a large array of body systems. This is not unexpected when you are dealing with a toxic substance which interacts with biological systems in a very fundamental way.

5.6 Among the NRC's significant conclusions was that fluoride was capable of interfering with the endocrine system, including accumulating in the pineal gland and lowering **thyroid function**. In other words, fluoride is an endocrine disruptor and this was the first time it was identified as such by a government-appointed panel.

5.7 The NRC panel also expressed concern about fluoride's potential to impact the **bone**. The NRC noted that the first symptoms of skeletal fluorosis (literally poisoning of the bone by fluoride) were very similar to arthritis; namely, stiffness and pains in the joints. They argued that this should be considered a more sensitive end point than the last phase of skeletal fluorosis (crippling skeletal fluorosis), which was the end point used by the EPA in determining its safe drinking water standards for fluoride in 1986 (discussed in section 6).

5.8 The author was the only opponent of fluoridation who was invited by the NRC panel to submit evidence in person. His submission, co-authored by his son Michael,¹⁵ drew special attention to animal and human studies that considered the lifetime accumulation of fluoride in the bone. While this accumulation makes the bones harder (i.e. increasing bone mineral density) it can also lead to brittleness and an increased fracture risk. The most serious risk in this respect is a weakening of the femoral neck giving rise to a concern

about an **increased risk of hip fracture** – which is very serious for the elderly. The human epidemiological studies on this matter are mixed. For a more detailed discussion of these studies, see chapter 17 (Fluoride and the Bone) in *our book*.¹

5.9 Most of the epidemiological studies on hip fractures in the elderly have been of an ecological design, i.e. exposure was assessed based on the fluoride levels at the location where the study and control group resided respectively. However, a study published in 2021 by a Swedish group was able to estimate exposure on an *individual* basis. They did this for a very large number of people drinking natural fluoride levels ranging from 0 to 1 ppm. They found a strong relationship between lifelong exposure to fluoride and increased hip fracture rates among post-menopausal women.⁶

5.10 In the author's submission to the NRC,¹⁵ the panel's attention was also drawn to the IQ studies emerging from China. At the time only 5 IQ studies were available, but they included a very important paper (and letter) by Xiang et al.^{16,17}

5.11 On the brain, the NRC panel concluded:

Animal and human studies of fluoride have been published reporting adverse cognitive and behavioral effects. A few epidemiologic studies of Chinese populations have reported IQ deficits in children exposed to fluoride at 2.5 to 4 mg/L in drinking water...the consistency of the results appears significant enough to warrant additional research on the effects of fluoride on intelligence." [p. 8]⁷

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. [p. 222]⁷

5.12 Throughout the review the NRC recommended many more studies be undertaken on many facets of fluoride's toxicity. Indeed, Dr. John Doull, the chairman of the NRC panel, in an interview featured in an article published in *Scientific American* (Jan, 2008), had this to say about the issue:

What the committee found is that we've gone with the status quo regarding fluoride for many years—for too long really—and now we need to take a fresh look . . . In the scientific community people tend to think this is settled. I mean, when the U.S. surgeon general comes out and says this is one of the top 10 greatest achievements of the 20th century, that's a hard hurdle to get over. But when we looked at the studies that have been done, we found that many of these questions

are unsettled and we have much less information than we should, considering how long this [fluoridation] has been going on.¹⁸

6. Current U.S. law does little to protect citizens from fluoride

6.1 The only agency that plays any official role in protecting the public from fluoride exposure via the water supply is the EPA. It has the responsibility of establishing a **federally enforceable** safe drinking water standard (the Maximum Contamination Level, MCL) and an **ideal goal** (Maximum Contamination Level Goal, MCLG). Such standards and goals are normally directed towards pollutants. Fluoride is unusual in that it is both a pollutant and a substance deliberately added to water for public health reasons (i.e. fighting dental disease).

6.2 **This is where politics appear again.** Unfortunately, the perceived benefit of water fluoridation has prevented the EPA from properly regulating fluoride for decades. The EPA has had to regulate fluoride with agencies of the giant National Institute of Health (NIH) looking over its shoulder. These include the U.S. Public Health Service (PHS), the Centers for Disease Control and Prevention (CDC) and the NIDCR (National Institute of Dental and Cranial Research). The latter is the largest funder of dental research in the world. All these agencies see protecting fluoridation as an important part of their mission.

6.3 In 1986, the EPA set both the MCL (its federally enforceable standard) and its MCLG for fluoride in drinking water at 4 ppm (4 mg/liter). A good description of this rulemaking was given on page 1 of the NRC report of 2006.⁷

6.4 The author would argue that if fluoride had *only* been an industrial pollutant, a far lower MCLG would have been determined.

6.5 **The MCLG is a level deemed safe based on the best scientific data with an adequate margin of safety to protect vulnerable subsets of the population.**

6.6 The MCL is set as close to the MCLG as economic and other considerations allow.

6.7 Usually, the MCLG is lower than the MCL, for example for arsenic the MCLG is 0 (because it is a known carcinogen) and the MCL is 10 ppb (because of the prohibitive costs of removal). In the case of fluoride both the MCL and MCLG were set at 4 ppm. This is very high considering that Canada, Mexico and the World Health Organization (WHO) all have standards or guidelines of 1.5 ppm.

- 6.8 While economic considerations may have justified a high MCL, it should not have influenced the ideal goal. **The MCLG should have been set much lower than the MCL.**
- 6.9 The EPA's risk assessment that underpinned the MCL/MCLG determinations was extremely crude, especially by today's standards. The EPA assumed that the most sensitive end point for fluoride's toxicity was **crippling** skeletal fluorosis – they didn't consider the earlier phases of this bone disease, which have symptoms like arthritis.
- 6.10 The EPA used a study of about a dozen industrial workers¹⁹ from the 1930s to estimate a lowest adverse effect level of 20 mg fluoride per day.
- 6.11 They then used a margin of safety of 2.5 to reach a "safe" level of 8 mg/day. A margin of safety of 2.5 would not protect against the full range of human sensitivity of the population for this end point. Normally, a margin of safety of 10 would be used at this step.
- 6.12 They did not include assessment of any other sources of fluoride exposure (e.g. toothpaste, pesticide residues etc.), which should have been subtracted from 8 mg/day before considering exposure from water consumption.
- 6.13 They assumed that the average consumption of water was 2 liters of water per day and thus calculated an MCL and MCLG of 4 ppm (2 liters at 4 mg/liter would deliver a "safe" level of 8 mg of fluoride per day). They did not consider a vulnerable subset in the population: high water consumers.
- 6.14 Incredibly, this unprotective and crudely determined standard (MCL) and goal (MCLG) of 4 ppm have not been changed since 1986.
- 6.15 **No tracking of the health risks of fluoridation by the CDC.** The CDC is the agency most associated with fluoridation in the USA. However, only one small division of this agency is involved. This is the Oral Health Division and its role is the promotion of the benefits of the practice, which it has done vigorously for decades. **There is no division at the CDC which has equivalent oversight for the risks the practice may pose.**
- 6.16 **The FDA plays no role** in overseeing the practice of water fluoridation, this it leaves to the CDC and the EPA. The FDA has never ruled on the efficacy or safety of fluoride via ingestion and its official position on fluoride supplements is that they are unapproved drugs. The FDA does play a role in regulating dental products and requires a **warning label** on fluoridated toothpaste in the U.S.

*Keep out of reach of children under 6 years of age. If you accidentally swallow more than used for brushing, seek professional help or contact a poison control center immediately.*²⁰

7. Fluoride's damage to the brain: the lowering of IQ

- 7.1** When the author first got involved in the fluoridation debate (1996) it coincided with the publication of the first two Chinese IQ studies published in the English literature.^{21,22} The author has followed this issue very closely ever since.
- 7.2** When the NRC published its ground-breaking review in 2006,⁷ there were only 5 IQ studies available in English. Since then the Fluoride Action Network has had many of the earlier and subsequent Chinese studies translated into English. By 2010, 23 IQ studies were available, including FAN's translations.
- 7.3** In 1995, one year before the Chinese IQ studies were published, a groundbreaking study on fluoride and animal behavior was published by Phyllis Mullenix.²³ Regrettably, when her study was accepted for publication her employer the Forsyth Dental Center fired Mullenix (she was chairperson of its toxicology department) stating that her work was no longer relevant to dentistry. Chris Bryson in the softback edition of his book *The Fluoride Deception*²⁴ writes more on the Mullenix issue.
- 7.4** For this author, Mullenix's firing was an early view of how political forces interfere with scientific results which threaten the practice of water fluoridation. In section 11, readers will see how intimidation has been used on key fluoride-IQ researcher Christine Till.
- 7.5** Returning to the science, there is a huge body of evidence from animal and human studies that fluoride is a potent developmental neurotoxic substance. This includes over 70 human IQ studies. A complete listing (and links to them) can be found on the website of the Fluoride Action Network.²⁵
- 7.6** The human IQ studies can be considered in two parts: those published before 2017 and those published after. Before 2017 the studies were done largely in areas endemic for dental and skeletal fluorosis in China, India, Mexico and Iran, with water levels usually higher than in artificially fluoridated communities.
- 7.7** The IQ studies published since 2017 have been largely based on individual measurements of fluoride exposure and conducted in areas with exposure levels at or close to the levels experienced in artificially fluoridated communities.

7.8 The early studies (before 2017) were nearly all of an ecological design in which fluoride measurements were based on measurements of **fluoride exposure made at the community as opposed to the individual level**.

7.9 In 2012, **27 of the IQ studies**, published between 1988 – 2012, were subjected to a **meta-analysis** by a team from Harvard University, which included Philippe Grandjean, one of the world's leading neuroscientists.²⁶

7.10 The meta-analysis authors²⁶ noted that many of the studies had weaknesses (particularly a lack of control of a number of conflicting variables) but they also noted that the **results were remarkably consistent** considering the investigations had been conducted **in widely different geographical areas, at different times over a 20-year period and by different research teams**.

7.11 The authors felt that because of the large variation in geographical location that there was unlikely to be a confounding variable that could explain this consistency. They concluded that arsenic (which also lowers IQ) was not likely to be such a confounding factor because it did not share the same geographical distribution as fluoride.

7.12 **Twenty six out of the 27 studies in the Choi²⁶ meta-analysis found a lowered IQ in the “high-fluoride” village compared with the low-fluoride village.**

7.13 The average lowering in these 27 studies was 7 IQ points. Such a downward shift in a large population would have huge ramifications. A shift downwards of 5 IQ points across a large population would approximately halve the number of very bright children (IQ above 130) and increase by about 60% the number of mentally handicapped (IQ less than 70) – see Figure 1. This in turn would have enormous social and economic consequences for any nation that deliberately exposes its whole population to this neurotoxic substance.

7.14 Fluoridation promoters have done their best to dismiss these findings claiming that the fluoride concentrations in the high-fluoride villages made the findings irrelevant to artificial water fluoridation programs. However, while it is true that in two of the studies the fluoride concentrations reached 11 and 11.5 ppm, respectively, these were at the high end of ranges i.e. 2-11 ppm and 3.8 - 11.5 ppm, respectively and not an average value. Nor were they typical of the whole data set, see Table 1.

7.15 From the data presented in Table 1 it can be seen that many of the studies had fluoride water concentrations less than 3 ppm and that the mean

for all the studies combined [as calculated by the author] was 3.52 ppm, which is lower than the U.S. EPA's current safe drinking water standard (4 ppm).

- 7.16** Moreover, as any toxicologist should know *when looking at a series of studies like this with respect to protecting the public from harm it is not the highest value, which is of concern but the lowest*. For the EPA it is the lowest value (i.e. the lowest observable adverse effect level, or LOAEL), which is the starting point for determining the safe reference dose (RfD) needed to protect all the individuals in a large population exposed to any toxic substance. For these 27 studies the lowest concentration at which an IQ drop was observed was 0.75 ppm (Xiang^{16,17}).
- 7.17** Xiang^{16,17} had divided his high fluoride village into 5 sub-sets with well-water ranging in concentration from 0.75 ppm to over 4 ppm. Xiang found a **dose response relationship** between a) fluoride concentration and lowered IQ, and b) fluoride concentration and the percentage of children with an IQ less than 80 (borderline mentally handicapped) (see Table 2).
- 7.18** Findings at such modest concentrations (overall less than 4 ppm and in Xiang's study less than 0.75 ppm) offer no adequate margin of safety to protect all children in a large population drinking fluoridated water (and getting fluoride from other sources) sufficient to protect against this serious harmful effect.
- 7.19** Despite their limitations these studies raised red flags at the **National Institute of Environmental Health Sciences (NIEHS)**. As result this research body set about funding such studies. Between 2017 and 2024, the NIEHS has funded at least 26 published studies pertaining to fluoride's neurotoxicity.²⁷
- 7.20** Meanwhile, in 2016 a study was published in New Zealand by **Broadbent et al**²⁸ which has been used by fluoridation promoters to negate all of the Chinese and other studies discussed above. However, even a lay reader of this study would be suspicious that it was biased. It was written by a dental researcher and fluoridation promoter, who, on the first page expresses his concerns that communities in the U.S. (Portland) and New Zealand (Hamilton) are rejecting fluoridation in referenda because of concerns they expressed about fluoride's neurotoxicity, which he claimed were based on flawed Chinese studies. *In my view this fluoridation promoter had an agenda, he clearly wanted to find that fluoride had no effect on IQ.*
- 7.21** Be that as it may, *it is a weak study* and a critique appeared in the same journal.²⁹ The critics explained that it had little power to find a difference in IQ between the children who drank fluoridated water and those who didn't. There were nearly 1000 children who grew up in a fluoridated area but less than 100

who did not. The authors decreased the power still further by **not considering total fluoride exposure** (instead of just water consumption). They did not consider exposure via tea (NZ is a big tea drinking country) toothpaste or via supplements. The latter omission was particularly serious because in the years covered by the study children living in non-fluoridated communities were normally given fluoride tablets. He also failed to control for several confounding variables, which ironically, he accused the Chinese of failing to do. This included lead exposure even though data was available to him on this. Indeed, the same cohort has been used to study lead's neurotoxicity.

7.22 On Sept 19, 2017 a study was published which made the controversy over the Broadbent study somewhat moot: the first of three groundbreaking U.S. government-funded Mother-Child cohort studies were published.³⁰⁻³²

7.23 Bashash et al. 2017.³⁰ This was a 12-year, prospective Mother-Child cohort study performed in Mexico City, using the ELEMENT cohort, which had been previously used in studies of other neurotoxic substances.

7.24 300 Mother-Child pairs were followed for 12 years. The mother's fluoride exposure was measured directly via urinary fluoride level and the paired offspring's IQ were measured (again individually) at 4 and 6-12 years of age. In Figure 3 a simplified version of the scatterplot of the data is shown.

7.25 The results were startling. The authors found a 4 to 5-point loss of IQ in offspring, associated with the range of maternal fluoride urine levels typical for a community with water fluoridation in the USA (see Figure 3).

7.26 All the criticisms of the earlier cross-sectional studies showing lowered IQ associated with fluoride, published in India, China and other countries, were addressed in this study. They controlled for every conceivable confounding variable.

7.27 Proponents of water fluoridation were quick to claim that the study was not relevant to the U.S. because Mexico does not fluoridate its water. However, Mexico does fluoridate its salt with the aim to deliver roughly the same amount of fluoride that would be received in a community with fluoridated water.

7.28 Moreover, the authors used **urinary fluoride levels** to monitor the mother's exposure to fluoride and these levels indicate **the total dose of fluoride** to which the mother was exposed during pregnancy and that is **independent of the source of fluoride**. Thus, the location of the study and the source of the fluoride made no difference to the relevance of the findings.

7.29 Green et al. 2019.³¹ The second of the U.S.-government funded studies was funded by both the NIEHS and Health Canada. It was published in *JAMA Pediatrics*. The authors essentially replicated the Mexican City study³⁰ findings with one major difference, they found a lowering of IQ in boys associated with the mothers' urinary fluoride levels but not in girls. ***However, using two other ways of assessing maternal fluoride exposure (estimated daily intake and local water fluoride levels) they found IQ lowered in both boys and girls.***

7.30 A 20-minute podcast³³ by two *JAMA* editors released at the same time as the article made it clear that they knew how controversial these findings would be so they gave it a more thorough peer review than normal.

7.31 Readers – especially those new to this controversy – are encouraged to listen carefully to the reaction of these *JAMA* editors in this podcast.³³ They were shocked by this Canadian study's findings. Based on their training at medical school they had no idea that fluoride posed any health threat – let alone to the brain. They had been taught, like nearly all medical and dental students that fluoridation was “safe and effective” and anyone that said otherwise was a crank. At the end of the podcast one editor said that if his wife were pregnant he would advise her to avoid fluoridated water. He explained that during gestation fluoride offers little benefit to the teeth and it would be worth hedging one's bets on the neurodevelopmental risks.

7.32 With these Mother-Child cohort studies^{30,31} it became clear that the period of fetal development is a very sensitive period as far as fluoride impacting brain development is concerned. This is a tragic outcome of the fact that the placenta does not prevent fluoride entry into the womb. Hitherto, no Western study had pursued fluoride's possible impact during the gestational period.

7.33 It should be noted that not only does the mother pass on any fluoride she ingests during pregnancy but she may also release some of the fluoride she has stored in her bones during prior years, if fetal calcium demand is greater than the mother can supply from her diet.

7.34 Till et al. 2020.³² The third of the important U.S. government-funded studies was published in 2020. In this study the authors showed that early infancy is another very vulnerable period as far as the brain and fluoride is concerned. They found a large significant lowering of IQ (i.e. up to 9 IQ points) for children who were bottle-fed in ***fluoridated communities*** in Canada (F level = 0.7 ppm or less) compared to those who were bottle-fed in ***non-fluoridated communities***.

7.35 Summary: A large body of scientific evidence indicates that fluoride can lower the IQ of children. High quality Mother-Child cohort studies funded by NIEHS, indicates that this can occur at levels experienced in fluoridated

communities.

8. No governmental warnings

8.1 Despite the evidence presented in section 7, no governmental agency in the U.S., Canada or other fluoridating countries, has warned pregnant women to avoid fluoridated water and other sources of fluoride.

8.2 Ever since the publication of the first Mother-Child cohort study³⁰ the Fluoride Action Network has been trying to get warnings to women to avoid fluoridated water during pregnancy. These efforts have included seeking help from the CDC' that has promoted fluoridation as "safe and effective" for many decades.

8.3 On Nov 1, 2021, the author had arranged a 30-minute Zoom call with the office of Dr. Karen Hacker, Director of the National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP) at the CDC, to hear from the key Mother-Child fluoride researchers: Christine Till, Bruce Lanphear and Philippe Grandjean.

8.5 In the Zoom call each of these experts spent 5 minutes describing their work. To the surprise and dismay of these scientists and myself, Hacker and colleagues at the CDC did not have a single question to ask them on their research findings, in the remaining 15 minutes. In the lull, I urged Dr. Hacker to issue warnings to pregnant women to avoid fluoridated water. The CDC has failed to do so.

8.6 **Summary:** No agency in any country practicing fluoridation (including the CDC in the USA) has issued any warnings to pregnant women to avoid fluoride, instead they continue to push for more fluoridation (see section 17).

9. The NTP's systematic review of fluoride's neurotoxicity (2016-2022)

9.1 In June 2015, Bill Osmunson DDS, MPH,³⁴ a member of the Board of Directors for the Fluoride Action Network, requested that the National Toxicology Program (NTP) review the neurotoxicity of fluoride. The NTP agreed to do so.

9.2 In 2019, and 2020, the NTP published two drafts of its review.^{35,36}

9.3 In both drafts the NTP science team concluded that fluoride was ***"presumed to be a cognitive neurodevelopmental hazard to humans."***^{35,36}

9.4 The NTP rating of "presumed" is the highest confidence rating possible without a controlled human experiment being available and such a study would be unethical.

- 9.5 The NTP asked the National Academies of Sciences, Engineering and Medicine (NASEM) to peer review their drafts.
- 9.6 NASEM did not review the scientific studies that were the basis for the NTP review, only whether or not that their systematic review met its own (NTP's) protocols for conducting such systematic reviews and whether they had communicated and explained their results and conclusions, clearly.
- 9.7 In a Letter Report, dated January 26, 2021, to the NTP, that accompanied its second NASEM peer review,³⁷ the NASEM committee Chairman, Dr. David Savitz, wrote:

...Even though the evidence provided appears to show consistent indications of an association between exposure to **high** fluoride concentrations and cognitive deficits in children, the monograph falls short of providing a clear and convincing argument that supports its assessment.

It also needs to emphasize that much of the evidence presented comes from studies that involve **relatively high** fluoride concentrations and that the monograph cannot be used to draw conclusions regarding low fluoride exposure concentrations (**less than 1.5 mg/mL**), including those typically associated with **drinking water fluoridation. (author's emphasis)**

- 9.8 FAN and others who have followed the literature closely on this matter were shocked with this conclusion because three U.S. government-funded studies³⁰⁻³² had been conducted either in communities in Canada with water fluoridated at 0.7 ppm or lower³¹⁻³² or in Mexico with equivalent exposure levels as indicated by maternal urine fluoride concentrations.³⁰
- 9.9 FAN argued that the idea of 1.5 ppm as a threshold was confusing "quantity" with "quality." If you included the cross-sectional studies from India and China, there were clearly *more* studies finding an adverse effect above 1.5 ppm but the *highest quality* studies were conducted below 1.5 ppm. In the author's view, ***quantity should not trump quality (we return to this discussion in section 14).***
- 9.10 Even so, **finding a lowering of IQ at 1.5 ppm offers no adequate margin of safety when you are exposing a large population of children to 0.7 ppm of fluoride in their drinking water.** There are three reasons for this:

- a) children drink different amounts of water,
- b) they get fluoride from other sources, mainly swallowing toothpaste with fluoride, and

- c) there is a wide range of sensitivity to any toxic substance among a large population.
- 9.11 Typically, regulatory agencies like the EPA would like a margin of safety of 10, 1.5 ppm only offers a margin of safety of 2.
- 9.12 Shortly after Savitz's Letter Report and NASEM review³⁷, the NTP dropped its "presumed neurotoxicant" conclusion, but instead decided to divide its report into a) a State of the Science monograph with no hazard conclusion at all and b) a meta-analysis paper to be submitted for publication in a journal.
- 9.13 FAN only became aware of this decision from a court filing³⁸ by the EPA lawyers in the TSCA lawsuit 13 days after the decision had been made. In their court brief, EPA lawyers filed a three-paragraph written statement from NTP announcing this decision.
- 9.14 The decision was *not* announced publicly by the NTP. The statement offers no cogent explanation for why this drastic change in the protocol for the NTP's evaluation was made.
- 9.15 This surprising decision by the NTP prompted FAN to file FOIA requests for correspondence between officials at the NTP and the EPA and the main pro-fluoridation agencies, the NIDCR and the CDC, as well as the major fluoridation promoter, the American Dental Association (ADA). See section 12.
- 9.16 As a consequence of the changes to the NTP mission, its earlier conclusion that fluoride was "*presumed to be a cognitive neurodevelopmental hazard to humans*" dropped out of public sight.
- 9.17 After the second NASEM review, Savitz appeared in a webinar³⁹ with Jay Kumar and Loc Do, both prominent promoters of fluoridation. What emerges from this webinar is an apparent effort to introduce ***the benefits of fluoridation*** to counterbalance the neurodevelopmental risks of fluoride, even though the NTP review strictly focused (as it should have) on the risks. Clearly, a risk-benefit analysis should only come ***after*** the risk has been established. Introducing a discussion of benefits ***before*** a risk assessment has been completed runs the risk of corrupting the risk assessment process.
- 9.18 It should also be noted that in the TSCA trial lawyers on both sides agreed to exclude any consideration of benefits.
- 9.19 Savitz subsequently appeared as an expert witness for the EPA in the TSCA trial (see section 18). In his deposition he admitted that he was not an expert on fluoride; that he had read none of the animal studies; that he read

only about 10 of the human studies; he read none of the human studies conducted above 1.5 ppm and had not even read the updated NTP monograph (i.e. the May 18 2022 draft) in which the NTP had responded to NASEM's and others' criticisms. Even with his skimpy background knowledge on the science of the matter, the EPA paid Savitz \$500 an hour for his services.

10. The TSCA petition and lawsuit against the US EPA

10.1 In this section, the separate but overlapping history of the TSCA (Toxic Substance Control Act) petition and the subsequent trial, will be examined.

10.2 In November 2016, using a provision in TSCA (Toxic Substances Control Act) FAN petitioned the EPA to ban the deliberate addition of fluoride to the public drinking water because of the threat (unreasonable risk) it posed to the developing brain. FAN provided hard copies of over 300 studies to support its petition.⁴⁰

10.3 In 2017, the EPA rejected FAN's TSCA petition. However, it did so on poorly argued scientific grounds which allowed FAN (along with Food and Water Watch and other plaintiffs in the case) to take the matter to Federal court in San Francisco. The case was held in June 2020 (via Zoom – with an estimated 500 observers).

10.4 By 2020, the evidence base had dramatically changed in FAN's favor with the publication of the U.S. government funded Mother-Child cohort studies.³⁰⁻³²

10.5 The plaintiffs' legal team were able to obtain expert testimony from some of the key researchers in the field of neurotoxicity including those who had authored key studies.³⁰⁻³² These included Howard Hu (Director of the ELEMENT cohort study in Mexico); Bruce Lanphear, a world-renowned expert on lead's neurotoxicity and co-author of two key MIREC cohort studies from Canada;^{31,32} Dr. Kathleen Thiessen a risk assessment specialist and Philippe Grandjean, a world-renowned expert on mercury's neurotoxicity and an expert on BMD (Benchmark Dose) analysis, used in risk assessment

10.6 **EPA uses Exponent, Inc. experts.** To the plaintiff's surprise, the EPA's lawyers (provided by the Department of Justice) chose not to use scientists from within their own agency as expert witnesses, but instead used the firm *Exponent, Inc.* This firm is very industry-friendly having defended the "safety" of such toxic products and/or contaminants as dioxins, PCBs, PFOS and glyphosate for its clients, which include Dow, Dupont and Monsanto.

10.7A level playing field. The judge in this case (Judge Edward Chen) has followed the science very closely and this trial offers the world a rare opportunity to examine the science of this matter **on a level playing field**. Under TSCA rules, the Judge is required to rule on the scientific merits of the science as presented by both sides, ***without deference to the EPA's regulatory authority***.

10.8 One important concession made by Exponent's experts during the trial is that the U.S. government-funded Mother-Child cohort studies³⁰⁻³² included as evidence in the plaintiff's case, are the highest quality human studies on fluoride conducted to date.

10.9 **The Judge intervened** several times during the EPA's closing arguments. (this was a bench trial not a jury trial). He rejected the notion that fluoride was not a ***hazard*** as far as neurodevelopment was concerned and he also opined that asking for proof of ***causation*** (as opposed to a statistically significant association) was holding the plaintiffs to a higher standard than TSCA required.

10.10 **The Judge delayed his ruling** on this case until the final report of the NTP's review of fluoride's neurotoxicity was made available. In addition, he wanted to see, a) a BMD analysis (discussed in the trial) after it has been published; a study from Spain (only the abstract was available at trial); and any other IQ studies in the works.

10.11 Before we get to part 2 of the TSCA trial, which took place in 2024, the author will describe some of the politics that have been employed by fluoridation promoters (inside and outside of government) to combat the far-reaching consequence of the human IQ studies (and the NTP's review of them) on the practice of water fluoridation. In short, it is clear that the Fluoride-IQ studies represent the biggest threat to water fluoridation in seven decades, and has put avid promoters of fluoridation into panic mode.

11 Enter the Politics: The Unprofessional Attack on Christine Till.

11.1 Ed Groth, III, who wrote his PhD thesis at Stanford University on the fluoridation debate, wrote these words in 1979 about the tactics used by some promoters of fluoridation:

"The politically minded zealots have used tactics of intimidation, professional and financial reprisals, derogatory personal attacks, and relentless public relations propaganda to silence scientific critics, to prevent the publication of adverse evidence and to make politically untenable any interpretation except the official view – that fluoridation is absolutely safe. Can scientific evidence really be suppressed in the free world? Easily."⁴¹

11.2 Readers new to this issue might think such a view is extreme. This section and the next, lends credence to Groth's commentary.

11.3 In an article⁴² by *Undark* journalist, Michael Schulson, he describes an orchestrated attack on Christine Till, one of the authors of the U.S. government funded Mother-Child studies.³² Schulson writes:

In 2021...[in reference to the Green, et al. 2019 study³¹] a group of academics and dental leaders [nearly all were well-known promoters of water fluoridation] filed a series of misconduct complaints with the researchers' institutions, as well as the U.S. federal government, which had funded the study.

"...that's terrible" said Hu, the physician and epidemiologist at the University of Southern California...Hu was not involved with the paper, but he has collaborated with Till on other research... "You don't do that," he said of the complaints, "unless you actually have evidence of scientific misconduct..."⁴²

11.2 In this same article, Schulson wrote about one of the instigators of the actions against Christine Till. He writes:

[Dr. Juliet] Guichon drafted the complaints in 2021. She ... recruited a group of dental and public health experts to sign it, including Howard Pollick, a dentist and clinical professor of health sciences at the University of California San Francisco, who often serves as an American Dental Association spokesperson on fluoridation; Christine Wood, the director of the Association of State and Territorial Dental Directors; William Maas, a former top dental official at the CDC; and Raman Bedi, the former Chief Dental Officer of England. [Scott] Tomar (the University of Illinois Chicago professor) joined the group as well.

The group fractured over how far to go...most of the signatories did not sign the complaint to York University, which called for...Till to be fired...⁴²

11.4 This is not the first time that Guichon has tried to get an opponent of fluoridation "fired." In her battle to restore fluoridation to Calgary she has also tried to get authorities in Alberta, Canada to retract the medical license of local doctor Robert Dickson for the offence of publicly opposing water fluoridation!

11.5 SUMMARY: proponents of fluoridation have a long history of attacking any study, or author of a study, which finds a result that threatens water fluoridation. Such attacks go way beyond professional criticism and often become highly threatening as in the orchestrated attack on Christine Till, discussed in this section.

12. FOIA requests reveal political pressures to prevent publication of the NTP report.

12.1 Prompted by NTP's sudden reversal on the scope of its review of fluoride's neurotoxicity. The plaintiffs in the TSCA trial filed numerous FOIA requests for correspondence between officials at the NTP and the EPA and well-known fluoridation promoters to see if any undue pressures had been applied on the NTP. What these FOIA requests found were shocking.

12.2 According to Michael Connett, the trial attorney for plaintiffs,

“... the emails make it pretty clear what happened- that the scientific conclusions of the NTP were not sufficiently compatible with the policy interests of water fluoridation. And that the NIDCR and the CDC, which are principally concerned with promoting this policy, found that unacceptable. They went up the ladder to the Assistant Secretary of Health and convinced the Assistant Secretary to order the NTP to not release the report...”⁴³

12.3 *Undark* journalist Michael Schulson, provides an inside view on how these interventions upset a key player at the NTP. In an interview with Dr. Brian Berridge, a former pharmaceutical industry scientist who led NTP's day-to-day operations at the time:

In April 2022, the NTP group was ready to publish its findings. “That’s when the wheels fell off,” said Brian Berridge... “After 17 years in ... industry, I’ve seen efforts to modify messages to fit commercial interests... I wasn’t party to that there, and I’m not game to do that here... [Berridge resigned in 2023] That’s not the way I want to do science.”⁴²

12.4 Dr. Berridge later agreed to be a Fact Witness (a person with knowledge about the relevant facts in a particular case) for the second phase of the TSCA trial.

13. Judge Chen demands that NTP report be made public.

13.1 When it became clear that the NTP report may never see the light of day, the plaintiffs in the TSCA trial went to the Judge and asked him to help make this May 18 2022 review publicly available. NOTE: The American Dental Association (ADA) the number one – non-governmental - lobbyist for fluoridation already had a copy of this report!

13.1 Judge Chen ordered that the NTP make available to the court the final draft of their review (which Mary Wolfe, a spokesperson for the NTP science team, had told the CDC was finalized and was to be released on

May 18, 2022) and agreed to make this a key document in phase 2 of the TSCA trial.

13.2 The NTP's finalized draft "State of the Science" monograph finally appeared on the NTP's website on March 15, 2023, along with the NTP's meta-analysis and other documents requested by Judge Chen.⁴⁸

14 Key findings in the NTP's finalized State of the Science monograph⁴⁴

14.1 The NTP's finalized report remained very strong in its findings. It identified 72 Human studies of which 64 found a connection between fluoride and IQ deficits and of **the 19 studies it deemed high-quality (i.e. low risk of bias) 18 found a lowered IQ.**

14.2 Chris Neurath analyzed the data in these 18 studies and presented their findings in a poster⁴⁵ submitted to the ISEE (International Society of Environmental Epidemiology) in 2023.

14.3 Of the 18 studies, 16 found an adverse effect, one no effect and one a large positive benefit (see Figure 3A and 3C)

14.4 Neurath states, "over 90% of studies in both exposure ranges (below 1.5 ppm and above 1.5 ppm) found statistically significant adverse associations"

14.5 "Subgroup meta-analysis found similar magnitude of effect [weighted average for each study totaled] in both exposure range subgroups [above 1.5 ppm and below 1.5 ppm] each subgroup averaging -3 IQ points per 1 mg/L F." (See the Forrest plots in Figure 3D)

14.6 Spline meta-regression did not suggest any threshold." (See Figure 3E)

14.7 Neurath's meta-analysis of these 16 studies suggests that no threshold has been demonstrated at 1.5 ppm or anywhere else for that matter. **A threshold at 1.5 ppm is a mirage.** How it arrived in the drafts of NTP reviews (and repeated by the NASEM peer review panel) is a mystery but there is no scientific basis for this conclusion.

14.8 **SUMMARY:** In its May 18 2022 "final" draft, the NTP reported 72 Human studies of which 64 found an association between fluoride and IQ deficits. Of the 18 studies deemed high quality (low risk of bias) 16 found a statistically significant lowering of IQ. Neurath's meta-analysis of these 16 studies suggests that no threshold has been demonstrated at 1.5 ppm.

15 The Spanish study

15.1 During the first phase of the TSCA trial (June 2020), the EPA made it known that there was a Spanish study using the INMA (Childhood and Environment) cohort which had not replicated the ELEMENT and MIREC cohort findings. However, this was only available as an abstract.

15.2 The study⁴⁶ was published in 2022. It used a part of the INMA cohort located in the Basque region. The lead author was Jesús Ibarluzea. Instead of finding a decrease in IQ in the children related to maternal fluoride exposure, he found a **massive increase in IQ** of 14 to 28 points for an increase of 1 mg/L of fluoride in the mothers' urine.

15.3 For fluoridation promoters this study was likely to be a major plank in the EPA's defense in phase 2 of the TSCA trial. For them, Ibarluzea was to the U.S. government funded Mother-Child cohort studies,³⁰⁻³² what Broadbent²⁸ (see section 7) had been to the Harvard meta-analysis.²⁶

15.4 If the Ibarluzea study was accepted at face value it would certainly lead to some doubt. **The appearance of this study, may not necessarily be explained by, but follows the same trajectory as the thesis described by David Michaels in his book "Doubt is Their Product: How Industry's Assault on Science Threatens Your Health."**⁴⁷ Michaels is an epidemiologist and Professor in the Departments of Environmental and Occupational Health and Epidemiology at George Washington University.

15.6 Stephen Gilbert in an excellent review of Michaels' book in *Environmental Health Perspectives*, gave this succinct summary of Michaels' thesis:⁴⁸

[R]ather than accepting the process of scientific discovery, business interests press to have every tiny bit of uncertainty explored before any policy decision can be made, demanding proof rather than precaution—in fact, they even manufacture uncertainty. As a result, decisions are not made; policy is not advanced; problems are not addressed.⁴⁸

15.7 However, **putting these conjectures aside**, there were major problems with the Ibarluzea study.

15.7.1 First, the relationship only held after urine fluoride levels were adjusted for creatinine. Even though this is a standard procedure it is surprising that this simple adjustment should lead to such a massive positive shift in IQ. Was there something wrong with the lab results? Unfortunately, the authors did not take any steps to pursue this question.

15.7.2 Second, even though this area in costal Spain was a huge consumer of locally caught fish, no adjustment was made for this potential confounding factor. The fish consumed were dominated by small oily fish and crustaceans. These would be high in Omega 3 oils which are known to be good for healthy brain development as well as high in fluoride – especially in the bones and scales, which are frequently consumed in such fish.

15.7.3 Curiously, the relationship between maternal fluoride levels and increased IQ was only apparent in the *non-fluoridated* communities not fluoridated ones. This would suggest a significant source of fluoride in the non-fluoridated communities other than fluoridated water – lending support for the notion of locally caught fish being a potential source.

15.8 Ibarluzea’s deposition. In November 2023, Michael Connett (plaintiff’s attorney in the TSCA trial) and Brandon Atkins (EPA’s lawyer) went to San Sebastian, Spain, to depose Ibarluzea in preparation for phase 2 of the TSCA trial.

15.9 After his deposition Ibarluzea refused any further participation in the trial.

16 Grandjean’s BMD analysis, 2024

16.1A Benchmark Dose Analysis (BMD). A BMD analysis is the EPA’s preferred method for assessing risk when linear dose-response data is available (i.e. in this case as the mothers’ urinary fluoride level goes up the IQ of her offspring goes down).

16.2 Such an analysis was performed by Grandjean et al in 2023⁴⁹ on the pooled Mother-Child data from both the Mexico (ELEMENT cohort³⁰), the Canadian (MIREC cohort^{31,32}) studies and data drawn from Mother-Child cohort study from Odense, Denmark. The benchmark risk was set at a loss of one IQ point and it was determined that the dose (benchmark dose) for that risk was 0.28 ppm fluoride in the mother’s urine.⁴⁹

17. More Politics: Health authorities in several countries continue to aggressively push fluoridation

17.1 Brian Martin in his book *Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate*⁵⁰ which was even-handed to both sides in the debate (unusual for its time), concluded that the decisive factor in winning the fluoridation debate was that the proponents had “political power” on their side. He wrote that in 1991. Today in the 2020s,

nothing seems to have changed. Despite all the evidence amassed that fluoride damages the developing brain, in the small fluoridating world, governments are either ignoring or dismissing this science and using their “political muscle” to force water fluoridation on more and more of their largely ill-informed citizens. Here are some examples.

17.2 **New Zealand.** On Nov 9 2021, “The New Zealand parliament voted unanimously...to pass a bill that will allow the Director General of Health to require water fluoridation in communities across the country...The measure is expected to increase the prevalence of fluoridation in the population from 50 percent to 80 percent.”⁵¹

17.3 **In the UK,** parliament passed the Health and Care Bill 2021⁵² which included two short paragraphs allowing the government to push through mandatory fluoridation, hitherto it had been a local community decision.

17.4 **Canada.** In Canada fluoridation promoters have gone to great lengths to re-introduce fluoridation into Calgary, Alberta. This was because, when councilors voted to halt the practice there in 2011, with a population of 1.3 million, it was the biggest loss ever experienced by the pro-fluoridation camp.

17.5 The campaign in Calgary was led by Juliet Guichon, discussed above (see section 15). Thanks largely to Guichon, with strong support from the American Fluoridation Society, local media and the Alberta Health Services, fluoridation proponents won a referendum on the issue, and in 2022 the Calgary council voted to approve the re-introduction of fluoridation.

17.6 Surprisingly, for a **government** agency, the Alberta Health Services, vigorously supported the pro-fluoridation vote in the **public referendum**.

17.7 **U.S.** In the U.S. the CDC contracted for, and approved the use of a Fluoridation Tablet delivery system (patented by a CDC employee!) to fluoridate remote rural areas.⁵³ This could extend fluoridation to another 19 million people.

18.TSCA trial phase 2, February 2024

18.1The TSCA trial with Judge Edward Chen presiding, resumed in Federal Court in San Francisco on January 31 and concluded on February 20, 2024.

18.2 The author watched every day of the trial, either in person or via zoom. But to cover the fascinating (and sometimes complex) details of this trial would take a whole book. Fortunately, several excellent reports from Dorothy Atkins (*Law 360*); Brenda Baletti, PhD (*The Defender*) and others have been collated and made available on the FAN website.⁵⁴

18.3 Expert witnesses. The plaintiffs (FAN et al) used the same experts as in phase 1 (Hu, Lanphear, Grandjean and Thiessen) as well as a Fact Witness (Dr. Brian Berridge, former Science Director at the NTP). For its expert witnesses the EPA used David Savitz, Professor of Epidemiology at Brown University and Chairman of the NASEM committee that peer-reviewed the NTP review and Dr. Stanley Barone the EPA's own risk assessment specialist.

18.4 Jesus Ibarluzea (Biodonostia Institute, Spain) the EPA's third expected witness, was deposed but refused to participate in the trial in person or via zoom. Parts of his videotaped deposition were presented in court instead.

18.5 Michael Connett, the plaintiff's lawyer summarized the large body of evidence that fluoride lowers IQ in children and reviewed by the NTP. Namely, a total of 72 Human studies of which 64 found an association between fluoride and IQ deficits. Of 19 studies, deemed high-quality (i.e. low risk of bias), 18 found a lowered IQ.

18.6 Connett then used the plaintiffs' experts to emphasize the high quality of the three NIEHS Mother-Child cohort studies for which they were co-authors.

18.7 Throughout the trial the EPA lawyers tried to throw doubt on all the studies conducted at low-levels (i.e. less than 1.5 ppm) claiming that they were unclear and inconsistent. They focused largely on the fact that the MIREC study³¹ did not find a lowering of IQ in girls, related to the mothers' urinary fluoride levels but glossed over the fact that the same study found an association between two other measures of the mothers' fluoride exposure which did. The EPA lawyers also dismissed the relevance of many of the high fluoride studies because they were done in foreign countries at higher levels than the level used in fluoridated communities in the U.S.

18.8 The EPA lawyers tried to nullify the findings of the ELEMENT and MIREC cohorts with the Odense and INMA cohorts (i.e. 2 versus 2!). This despite the testimony from all the plaintiffs' experts that the results of the Ibarluzea (INMA) study were implausible if not impossible. No substance has ever been shown to increase the IQ of children by 15 points. They pointed to Ibarluzea's failure to examine seafood consumption as a confounder and his failure to pursue why creatinine adjustment made such a difference to his findings and argued that Ibarluzea didn't carefully check the lab results which underpinned such an unlikely finding.

- 18.9** The EPA's lawyers used Dr, David Savitz to emphasize the uncertainty of the data on low fluoride exposure (less than 1.5 ppm).
- 18.10 The plaintiff's lawyer reminded the court that Savitz admitted he only read about 10 IQ studies and none above 1.5 ppm. He also questioned his possible pro-fluoridation bias, pointing out that he had agreed to serve on a Health Canada review panel even after he had been retained by the EPA to be an expert witness at \$500 an hour. At least two other members of the Canadian panel were known to be strong supporters of fluoridation. [Health Canada is renowned for selecting pro-fluoridation panels to rubber stamp the safety of fluoridation, see page 242 in our book¹]
- 18.11** The EPA's witness, Stanley Barone, a risk assessment specialist, stressed uncertainty, and despite the availability of 64 human studies finding an association between fluoride and lowered IQ, would not agree, with any confidence, that neurotoxicity was even a "hazard" of fluoride exposure, let alone an unreasonable risk.
- 18.12** The plaintiff's lawyer pointed out the double standard between Barone's reluctance to find a hazard with fluoride and his risk assessments for 10 industrial chemicals. None of them had anywhere near the number of human studies that fluoride has. In fact, in some there were no human studies at all!
- 18.13** Connett also argued that Barone demanded precision where no precision was necessary before drawing inferences on both fluoride's hazard and risk.
- 18.14** For example, Barone argued a) the need to use a PBPK (Physiologically based pharmacokinetic) model to determine level of fluoride in the brain rather than use the exposure level in mothers' urine; and b) the need to quantify all the sources of fluoride in mother's urine, before acting on one source (i.e. water fluoridation).
- 18.15** At times, while listening to Barone's tortuous arguments, this author felt he was being treated to an exercise in "obscurantism," which is defined as "the practice of deliberately preventing the facts or full details of something from becoming known."
- 18.16 In short, what Barone was able to do for ten industrial chemicals with very little human data, he couldn't do for fluoride despite the availability of over 70 human studies; 3 high quality U.S. government-funded studies; a 6-year NTP review and a BMD analysis of over 1500 mother-child data points.
- 18.17** Much of the trial (and the judge's questions) focused on choosing a suitable Point of Departure (POD): the starting point in a risk assessment. It

is a confusing topic and needs some careful explanation to understand the court debate and the judge's questions.

18.18 The POD is either a NOAEL (No Observed Adverse Effect Level) or derived from the lowest level at which harm is found. This level is either the benchmark dose or concentration obtained from a BMD analysis (the EPA's preferred method) or a LOAEL (Lowest Observed Adverse Effect level).

18.19 The second step in a risk assessment is to apply a **Margin of Safety**. It is needed because the POD is usually deduced from just one study, and it would not normally embrace the full range of susceptibility in a large population. In his deposition, Barone stated that for fluoride's neurotoxicity the Margin of Safety should be 10. This was a key admission.

18.20 For the purposes of this discussion the author is going to use "**presumed safe level**" as a more understandable term for the level reached after the POD (e.g. NOAEL) has been divided by the margin of safety. The EPA refers to this as the "Hazard level," but since we are actually into the risk assessment process at this stage it would be better called a "No risk" level. Whatever term is used the idea is that this is the level of the chemical which presents no threat to the population in question, including vulnerable subsets.

18.21 Then the third step in risk assessment is to compare this "presumed safe level" or "no risk" level to the exposure level for the population in question, which in this case is 0.7 ppm fluoride in the drinking water supply.

18.22 If the exposure level is over the "**presumed safe**" level then it clearly **presents an unreasonable risk**. But according to procedures used in the EPA's risk assessment for 10 industrial chemicals, it can be still judged an unreasonable risk even when exposure levels are **10-70 times lower than their "presumed safe" level**.

18.23 Barone admitted that "something was going on at high doses" in the fluoride studies but he claimed he couldn't confidently come up with a POD.

18.24 The plaintiff's lawyer argued that the ideal POD would be the benchmark concentration limit (BMCL) of 0.28 ppm fluoride derived from Grandjean's BMD analysis.⁴⁹

18.25 However, the EPA's lawyers had done everything they could do to throw doubt on Grandjean's BMD analysis,⁴⁹ arguing that it was driven by higher doses and questioned whether a linear model was the best fit to the data.

- 18.26** Michael Connett counter-argued that Grandjean had also used a non-linear model and arrived at a BMCL of 0.78 ppm, which could also be used as a POD.
- 18.27** Connett further argued, even if you put Grandjean's analysis to one side, you could very conservatively use the NTP's "threshold" of 1.5 ppm as a LOAEL to derive a POD.
- 18.28** According to this author, whichever POD method chosen (from the above), a population drinking water at 0.7 ppm will have a majority of its citizens (including vulnerable subsets) exposed to levels **well above** any of the "presumed safe levels" (i.e. the EPA's "hazard" level). **In other words fluoridation poses an unreasonable risk and the plaintiff's case is proved.**
- 18.29 After testimony had been completed, the Judge posted an order demanding the lawyers address **10 questions**⁵⁵ in their closing arguments.
- 18.30 A reading of these questions would indicate that the judge was skeptical about the EPA expert's inability to find a POD.⁵⁵
- 18.31** The demeanor of EPA's lawyer noticeably changed after receiving the Judge's 10 questions. In his closing arguments he became far more strident. For example, Grandjean's BMD analysis was "junk;" the Point of Departure could be anywhere from 0.2 to infinity (!) and if the judge ruled in favor of the plaintiffs he would be "an outlier."
- 18.32** The judge's ruling came on Sept 25, 2024.⁵⁶ In an 80-page ruling he very forcefully ruled in the plaintiff's favor. Judge Chen concluded that:

"Plaintiffs have proven, by a preponderance of the evidence, that water fluoridation at the level of 0.7 mg/L—the prescribed optimal level of fluoridation in the United States—presents an unreasonable risk of injury to health or the environment, without consideration of costs or other non-risk factors, including an unreasonable risk to a potentially exposed or susceptible subpopulation under the conditions of use." 15 USC §2620(b)(4)(B)(ii)¹

19 Conclusions

19.1 With studies funded by agencies of the U.S. government indicating that fluoride can damage the developing brains of some children living in artificially fluoridated communities, it is time to end this only modestly effective practice.

19.2 While the science is clear, government agencies in the countries (largely English-speaking) that support this practice seem loath to accept it.

19.3 Instead of warning citizens about the dangers, they are stepping up their efforts to fluoridate more communities, even to the point of introducing mandatory fluoridation in the NZ and UK. This is not only a tragedy for children whose future success in life is being compromised but also for the notion that public health policy should be informed by objective science.

19.4 Both the opponents and promoters of fluoridation have long eagerly awaited the decision of a federal court judge as to whether in his view the science indicates that the deliberate addition of fluoride to the public drinking water poses an unreasonable risk to the developing brains of children. Now the judge has ruled.

19.5 Needless to say, the author of this chapter had long hoped ***that science would triumph over politics***. A reading of the Judge Chen's ruling on Sept 25, 2024 will clearly show that is exactly what has happened. Truth has been taken to Power: David has beaten Goliath.

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Does Verlag want, or need this section?

Frequently Asked Questions and Answers

1) Can you remove fluoride from water by boiling?

No.

The fluoride ion is present in solution as an ion, when you boil the water the water molecules come off as steam but the fluoride ions remain with their metal ion partners (e.g. Ca^{2+} , Mg^{2+} ions) remain in solution and eventually are left as a solid sludge after all the water has boiled off.

2) Do counter filters remove fluoride?

No.

These filters use activated charcoal which are good at removing chlorine, organochlorines and some metal ions but not fluoride.

3) What is the best way of removing fluoride?

- a) Find out if there is a local group organizing to get your local council to stop fluoridating the water and help them!

- b) Next, check to see if there is a local spring in your area and fill several large bottles once a week (the author did this in Binghamton, NY for several years – the spring was 20 miles away).
- c) Purchase spring water from local supplier who will also provide a dispensing system. Ask for test results of fluoride levels.
- d) More expensive systems including reverse osmosis and ion exchange remove fluoride ions but both have to be recharged at intervals. Table top distillation systems are available. All three of these systems have the disadvantage of also removing metal ions like Ca^{2+} , Mg^{2+} ions which are important nutrients. If you choose one of these purchase a nutrient mix from your nature store.

4) If you had to select two videos of all those produced by the Fluoride Action Network, which two would they be and why?

- a) The best at summarizing the science of the anti-fluoridation position is “Professional Perspectives on Water Fluoridation.”

Available from: <https://fluoridealert.org/fan-tv/prof-perspectives/>

Michael Connett produced this videotape in 2008 as a parting gift before he went to law school. He assembled clips from a veritable Who’s Who list of fluoridation opponents and independent scientists. These included, **Arvid Carlsson**, Nobel laureate and opponent of fluoridation in Sweden, now deceased; **Hardy Limeback**, Canada’s leading dental researcher and member of the 2006 NRC (2006) panel; **Bill Hirzy**, former Senior scientist at the EPA; **Bob Carton**, former president of the Union that represented scientists at the EPA; **Lord Baldwin**, a leading opponent of fluoridation in the UK, now deceased; **Phyllis Mullenix**, author of the groundbreaking paper on fluoride and animal behavior in 1985; **Vyvyan Howard**, an infant and fetal pathologist; **Kathleen Thiessen**, a risk assessment specialist and NRC (2006) panel member; **Bob Isaacson**, a neuroscientist and member of the NRC 2006 review panel, now deceased); **Sir Ian Chalmers**, one the founders of the Cochrane collaboration; **Bill Osmunson DDS, MPH Brent Foster** and **Tim Kropp**, both environmentalists and myself.

The video also includes black and white footage of Harold Hodge standing in front of blackboard declaring that “at 1ppm fluoridation is safe.” Harold Hodge was chief toxicologist for the Manhattan project and oversaw the fluoridation trial in Newburgh/Kingston NY. He was the most prominent scientist advocating for the safety of fluoridation.

- b) The best video for providing a glimpse of the formidable interests promoting and protecting fluoridation – especially in the early days - is my interview with Christopher Bryson, author of *The Fluoride Deception*.

Connett P. *The Fluoride Deception: an interview with Christopher Bryson*. Fluoride Action Network. 2006. Available from: https://www.youtube.com/watch?v=Ly_QP4rGczo

The most striking aspect of Bryson's evidence is the collusion between U.S. Public health officials and the Fluorine Lawyers Association, who defended companies like ALCOA from lawsuits dealing with fluoride pollution.

4. Other than your own, which Books would you recommend for further research on this topic?

In chronological order of publication:

- i) Fred Exner and George Waldbott with J. Rorty (ed). *The American Fluoridation Experiment* (Devin-Adair, 1957; revised 1961).
- ii) George Waldbott, *A Struggle with Titans—Forces Behind Fluoridation* (Carlton Press, New York, 1965).⁶
- iii) George Waldbott, Albert Burgstahler and McKinney, *Fluoridation: The Great Dilemma* (Coronado Press, Lawrence, KS, 1978).
- iv) John Yiamouyannis, *Fluoride: The Aging Factor*, 3rd ed., Delaware (Ohio: Health Action Press, 1993. Note: First edition published in 1983, and second edition in 1986)
- v) Wendy Varner, *Fluoride in Australia: A Case to Answer*, 1986.
- vi) Brian Martin, *Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate* (SUNY press, 1991).
- vii) Phillip Sutton, *The Greatest Fraud: Fluoridation*, 1996.
- viii) Chris Bryson, *The Fluoride Deception* (Seven Stories Press, NY, 2004 (hard cover) and 2006 (soft cover with new introduction).
- ix) Bruce Spittle, *Fluoride Fatigue. Fluoride poisoning: is fluoride in your drinking water, and from other sources, making you sick?* (Paua Press, Dunedin, NZ, 2008)

6. Why do proponents spend so much money, time and energy pushing and defending the practice?

For the author, who has spent 28 years battling this practice, this has been the most difficult question to answer. We spent a whole chapter in our book¹ trying to do this (see chapter 26, The Promoters' Motivations).

Many individual dentists are simply "true believers" in this practice, and are proud of it. The main problem with this group is that they do not seem to have the time to actually read the literature. Instead they take the self-serving arguments of the ADA and the CDC at face value.

While there are a few large economic interests involved, including the sugar and related industries, dental products industry and the phosphate fertilizer industry. I do not think anyone of these is the crucial driving force, or explains all the angst involved. I may be wrong

Instead, I believe that, especially government public health agencies, they believe that if they lose fluoridation it will be a huge blow to their credibility and that in turn would lead to loss of the public's trust.

As far as public health measures are concerned having the public's trust is paramount. Lose that and you threaten other public health measures like vaccination. Thus, while fluoridation as a measure represents very little in terms of the national economy, vaccination is worth billions.

Or put it in more general terms, governments want to retain the prerogative to override the individual's right to informed consent to medication.

Figures and Tables

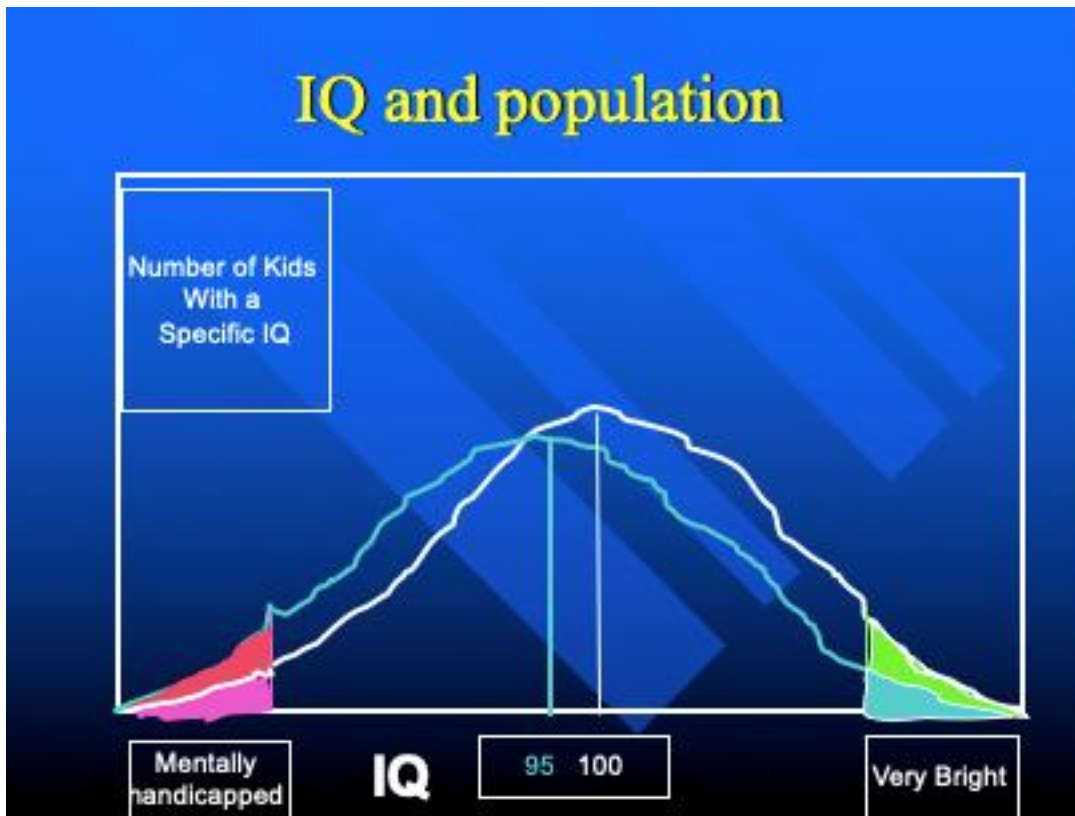


Figure 1. This figure is the author's very rough diagram illustrating the normal distribution of IQ in a large population. This is the famous "bell-shaped curve." Note a shift downwards of 5 IQ points (shift to the left) makes only a small difference to the average child with an IQ of 100, but a huge difference to the tails. Note the (shaded) areas under the curve represent, a) in the right corner, the fraction of children in the population with an IQ greater than 130 (the green areas represent the fraction of the population which are very bright, and represent 2% of the population) and b) in the left corner, the fraction of children with an IQ less than 70 (the red areas represent the fraction of the children deemed intellectually disadvantaged). Notice the 5 IQ point shift down approximately halves the number of children in the very bright category and increases by about 60% the number in the intellectually challenged category.

Relationship between fluoride and IQ found in new study (Bashash et al. 2017)

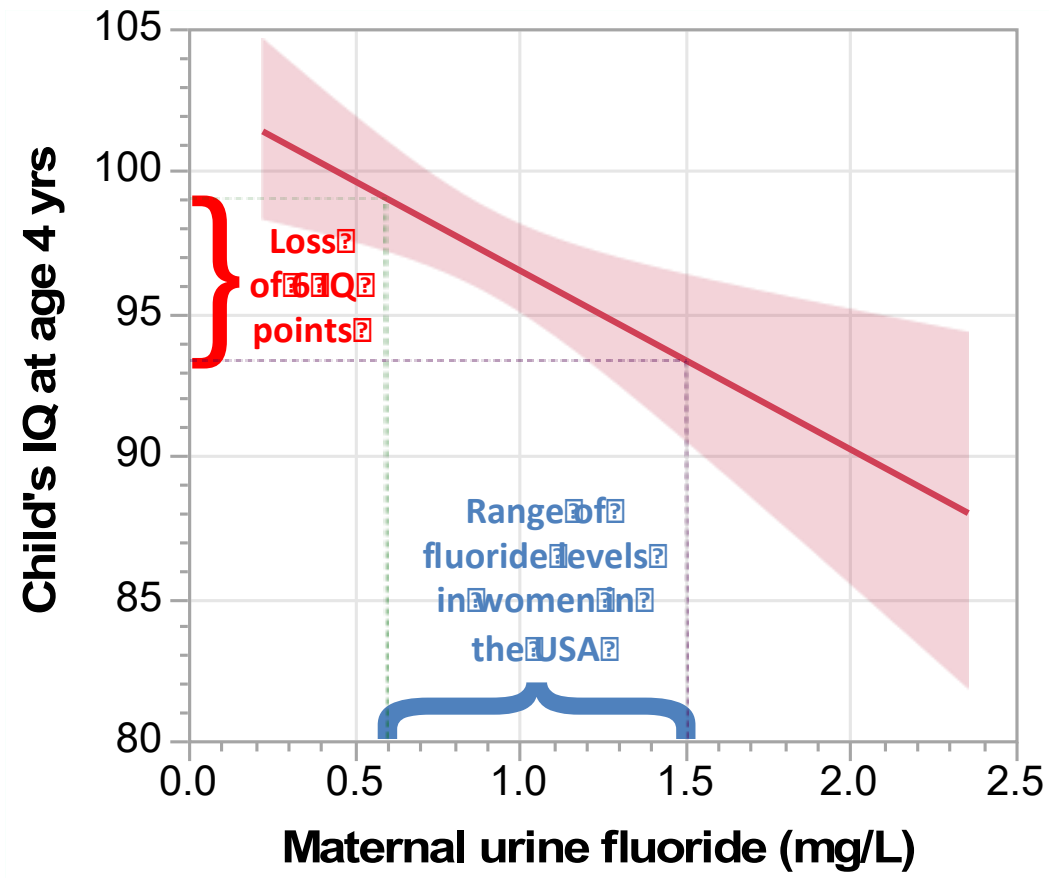


Figure 2: A simplified version of the scatterplot for the 300 mother-infant pairs in the Mexico City Mother-Child cohort IQ study.³⁰ The IQ at age 4 for the infants was plotted against the mothers' urine fluoride levels. This simplified version of the scatterplot was prepared by Chris Neurath (science director for the American Environmental Health Sciences Project), who has indicated the estimated range for the urinary levels of pregnant women in the U.S.



Updated dose-response assessment and meta-analysis of fluoride developmental neurotoxicity studies rated higher quality by the National Toxicology Program



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BACKGROUND AND AIM: The US National Toxicology Program (NTP) updated their systematic review of fluoride (F) human developmental neurotoxicity studies in 2022 [1]. In response to National Academies (NASEM) committee recommendations the present study assessed dose-response relationships in NTP-identified studies using rigorous methods consistent with Environmental Protection Agency (EPA) risk assessments.

METHODS: Studies rated higher quality (lower Risk of Bias) in the updated NTP review were evaluated using three approaches to assess dose-response relationships and possible thresholds [2]. The first approach assessed consistency of effect direction by comparing the number and proportion of studies finding statistically significant adverse associations of IQ with F at mean exposures <1.5 or ≥ 1.5 mg/L water F (or urine F) compared to studies finding no significant effect or a significant beneficial effect. The second approach used subgroup meta-analysis to compare pooled estimates of studies with individual-level exposure data with mean F >1.5 compared to mean F ≤ 1.5 mg/L. The third approach was meta-regression of IQ loss at mean exposure by mean exposure for studies with individual-level data. Linear and spline meta-regression models were assessed.

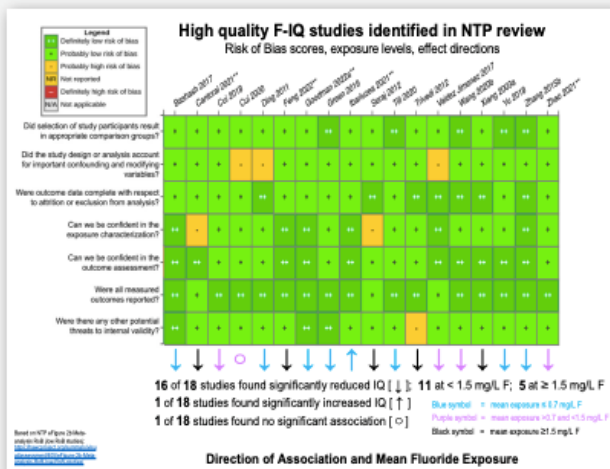
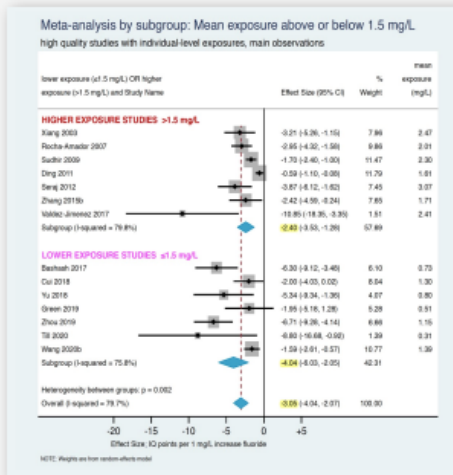
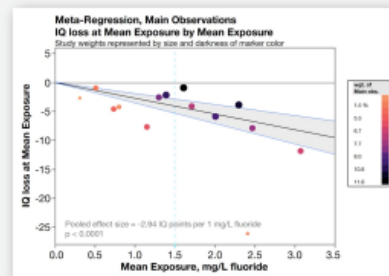


Figure 3a: This is the top half of the poster presented by Neurath to the ISEE in 2023.⁴⁵

assessed.



RESULTS: NTP rated 31 neurotoxicity studies higher quality, with 18 being of F and IQ. Over 90% of studies in both exposure ranges (<1.5 and ≥1.5 mg/L F) found statistically significant adverse associations. Subgroup meta-analysis found similar magnitude of effect in both exposure range subgroups, averaging -3 IQ points per 1 mg/L F for the two subgroups. Linear meta-regression also found a statistically significant pooled effect magnitude of -3 IQ points per 1 mg/L F. Spline meta-regression did not suggest any threshold.



CONCLUSIONS: A large number of high-quality studies consistently showed statistically significant adverse neurocognitive effects at both higher and lower exposure levels. Three dose-response assessment approaches were robust in finding no evidence of a safe threshold for IQ loss, including at exposure levels of 0.7 mg/L F and below.

REFERENCES:

Figure 3b: This is the bottom half of the poster presented by Neurath to the ISEE in 2023.⁴⁵

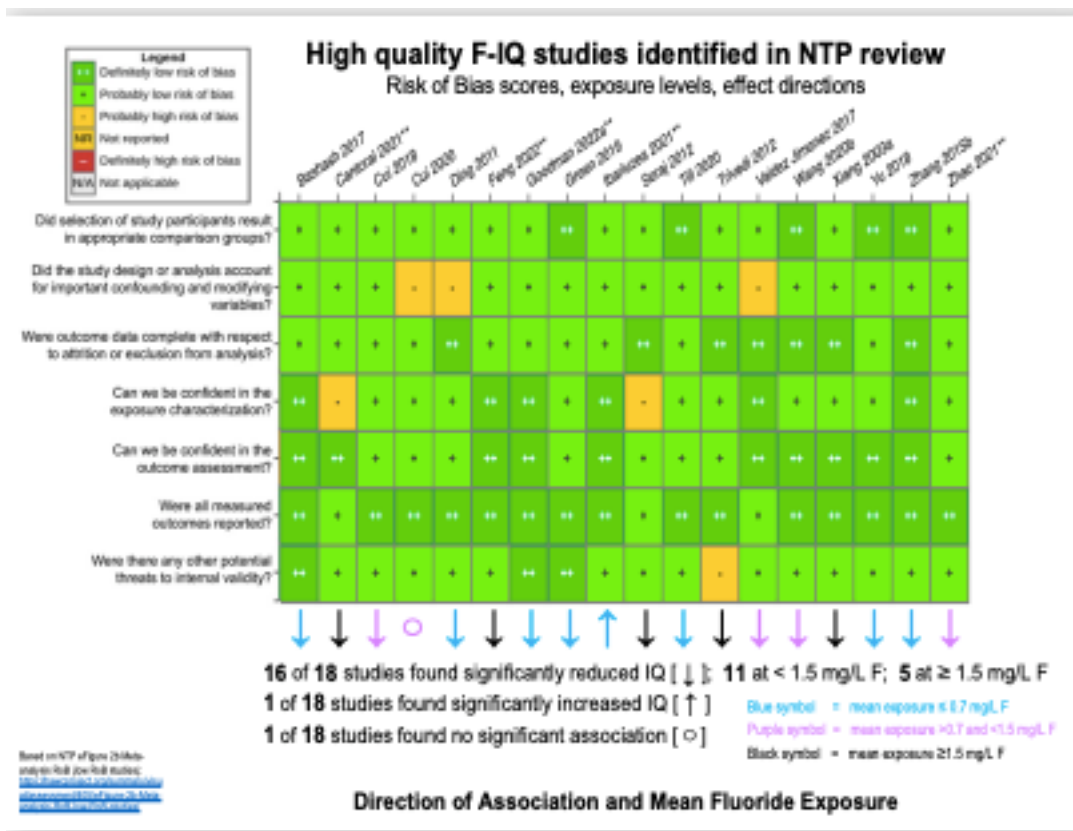
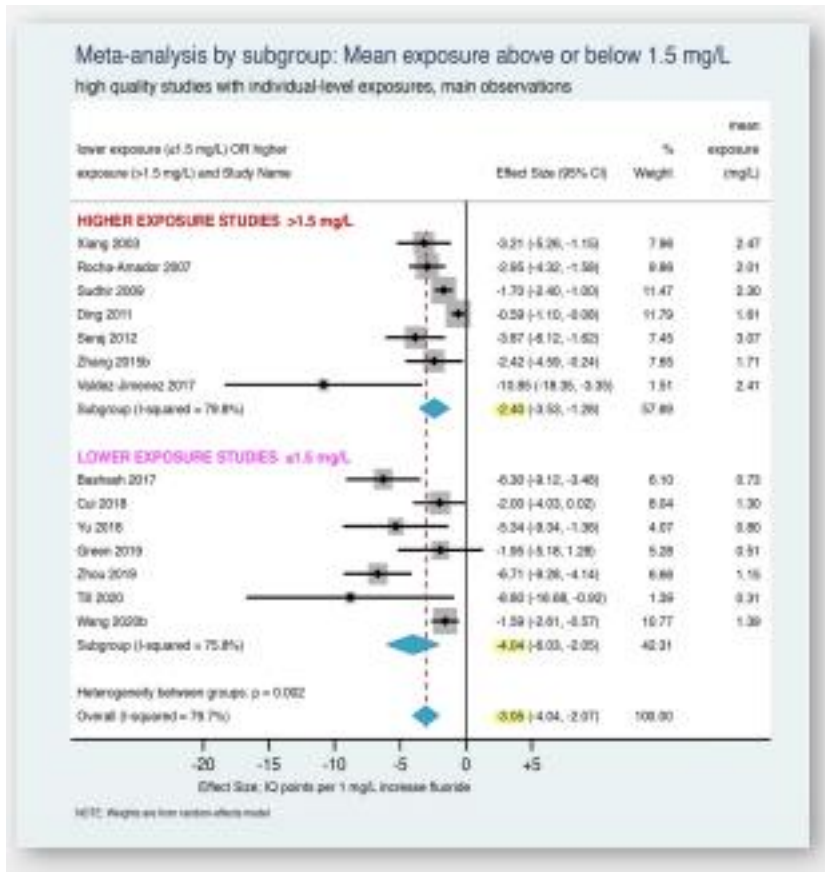


Figure 3c: An expanded view of the “heat map” shown in the top half of the poster presented by Neurath to the ISEE in 2023.⁴⁵ Neurath summarizes his analysis of 18 IQ studies deemed by the NTP to have low risk of bias (i.e. high quality). 16 found a statistically lowering of IQ (depicted by the downward arrows in the picture); one found a large benefit depicted by an upward arrow and the other found no effect, depicted by a circle. Of the 16 that found a lowering of IQ, 7 did so at a fluoride concentration less than, or equal to, 0.7ppm fluoride (light blue arrows), another 4 did so below 1.5 ppm (purple arrows) and 5 at above 1.5 ppm (black arrows). That’s 11 below 1.5 ppm and 5 above 1.5 ppm.



3d This is an expanded view the left-hand figure shown in 4B. It features two Forrest plots for two subgroup meta-analyses performed by Neurath.⁴⁵ The upper plot is for studies with fluoride exposure levels above 1.5 ppm fluoride and the lower plot for studies with exposure levels equal to or lower than 1.5 ppm, respectively. The blue diamonds on the figure represent the weighted average of the “magnitude of effect” in each subgroup. Both weighted averages were found to be -3 IQ points. Thus, the NTP’s notion of a threshold at 1.5 ppm appears to be incorrect.

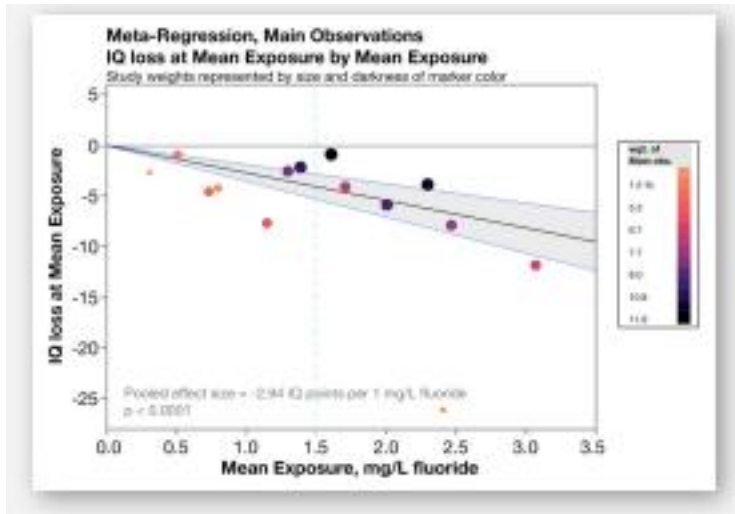


Figure 3 E: This figure represents the result of a Spline meta-regression by Neurath.⁴⁵ This plot shows no indication of any threshold in the fluoride concentrations at which an effect was observed.

Table 1: The data from the Choi et al. 2012 meta-analysis,²⁶ summarized with means calculated by the author (PC)

Author/year

ppm in High F village

Chen 1991	4.55
Lin 1991	0.88
An 1992	2.1 – 7.6 (mean = 4.9)
Xu 1994	1.8
Yang 1994	2.97
Li 1995	1.81 – 2.69 (mean = 2.25)
Yao 1996	2 – 11 (mean = 6.5)
Zhao 1996	4.12
Yao 1997	2
Lu 2000	3.15
Hang 2001	2.90
Wang 2001	2.97
Xiang 2003	0.57 – 4.5 (mean = 2.54)
Seraj 2006	2.5
Wang 2006	5.44 +/- 3.88 (1.52 – 9.32)
Fan 2007	1.14 - 6.09 (mean = 3.62)
Wang 2007	3.8 – 11.5 (mean = 7.65)
Li 2010	2.47 +/- 0.75 (1.72 – 3.22)
Poureslami 2011	2.38
Wang 1996	>1- 8.6 (mean = 4.8)

Mean of 20 results (using means) = 70.49 / 20 = 3.52

Taken from Choi et al, 2012 – Table 1, pp 24-26.

Table 2 is Table 8 in Xiang's 2003 paper.¹⁶ He divided up the children in the High-Fluoride community into five groups A-E with ascending well-water fluoride concentrations (from 0.75 to 4.15 ppm). Xiang shows two trends with these rising fluoride concentrations: a) a *decrease* in average IQ [from 99.56 to 78.38] and b) an *increase* in the percentage of children in each group with an IQ lower than 80 [i.e. border line mentally handicapped] from 0 to 37.5 % Both trends appear to show a linear dose response relationship.

Table 8. Level of fluoride in drinking water and children's IQs

Village	F in drinking water (mg/L)			IQ and rate of retardation		
	Group	No. samples	Water F level (Mean±SD)	No. children	IQ (Mean±SD)	Rate of IQ<80 (%)
Xinhuai	F	290	0.36±0.15	290	100.41±13.21	6.55
Wamiao	A	9	0.75±0.14	9	99.56±14.13	0.00
	B	42	1.53±0.27	42	95.21±12.22*	9.52
	C	111	2.46±0.30	111	92.19±12.98 [†]	14.41*
	D	52	3.28±0.25	52	89.88±11.98 [†]	21.15 [†]
	E	8	4.16±0.22	8	78.38±12.68 [†]	37.50 [†]

* $p < 0.05$. [†] $p < 0.01$ compared with group F.