

# Sustainable development and toxic chemicals: the case of fluoride

The use of fluorides in dental public health is an example of a class of chronically toxic chemicals that escapes the usual regulatory/assessment processes, avoids the fundamental principle of toxicology (namely to protect those at greatest risk) and violates medical ethics. Furthermore, it is argued here that the promotion of fluoridation uses the image of science while avoiding and misrepresenting its substance.

## Introduction

Sustainability is the goal or end-point (if there is an end-point) of the process known overseas as 'sustainable development' or, in Australia, as 'ecologically sustainable development' (ESD). There are many definitions of ESD. One alternative to the well-known Brundtland definition is 'types of economic and social development that protect and enhance the natural environment and social equity'.

One of many threats to both the natural environment and social equity comprises the many chemicals, both artificial and natural, that are present in food and drink consumed by humans. This article focuses on fluoride, which has been largely ignored in Australia as a toxic chemical, because of its use in public health dentistry.

Fluoride exists naturally in surface drinking waters, usually at levels in the range 0.1–0.2 ppm.<sup>1</sup> In six countries – USA, Australia, New Zealand, Ireland, Singapore and Columbia – more than 50% of the population is exposed to drinking water fluoridated artificially to about 1 ppm (i.e. 1 mg fluoride per litre of water) by public health authorities. Depending upon the quantity of tap water ingested both directly and indirectly through food processed with fluoridated water, this results in

daily fluoride doses approximately in the range 1.5–6.5 mg. In continental Europe fluoridation has been discontinued or never implemented almost everywhere, because of concerns about its safety and effectiveness.

## Fluoride as a toxic chemical

In most cases where fluoride is added to public water supplies, it is in the form of either fluorosilicic acid ( $\text{H}_2\text{SiF}_6$ ) or sodium silicofluoride ( $\text{Na}_2\text{SiF}_6$ ), both of which are obtained from the untreated waste liquor from cleaning the scrubbers in phosphate fertiliser manufacturing plants. This source of fluoride contains traces of arsenic, cadmium and other toxic chemicals, yet it has never been tested for safety by the US EPA or Australian authorities. However, fluoride toothpaste generally contains about 1000 ppm of pharmaceutical-grade fluoride.

It is well known that fluoride is a highly reactive biochemical agent. It forms a strong hydrogen bond with the groups found in proteins and nucleic acids,<sup>2</sup> and hence can and does inhibit and/or activate many enzymes, hormones and G-proteins. A review of the international scientific literature reveals that fluoride at the concentration of about 1 ppm in drinking water has *inter alia* the actual and possible health hazards summarised in Table 1.

Most of these hazards are discussed in a concise semi-popular review of the scientific literature

published recently by this author.<sup>3</sup> For more details with extensive reference lists, visit the websites included in the first note of Table 1.

A key matter for concern is that the health hazards of fluoride result from systemic effects, while the limited benefits are topical (i.e. acting directly on the surface of teeth). There is now a large body of scientific evidence supporting the latter result, to the extent that even the pro-fluoridation US Centers for Disease Control acknowledge that fluoride's mechanisms of action on teeth are 'predominantly topical'.<sup>4,5</sup> But dental and health authorities still claim incorrectly that there is substantial benefit from ingesting this toxic chemical.

## Are there some topical dental benefits?

Very briefly the scientific observations are:

- Large reductions in dental caries were observed in both fluoridated and unfluoridated communities in many developed countries, including Australia, in the 1960s and 1970s.<sup>6</sup> These reductions occurred before fluoridation in several subsequently fluoridated communities (e.g. Sydney pre-1968) and before the use of fluoride toothpaste became widespread.
- Randomised controlled trials (RCTs) show that fluoride toothpaste with 1000 ppm fluoride is effective, but no RCTs

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**Table 1 Some actual and potential health hazards from fluoridated water (1 ppm fluoride)**

Health hazard	Scientific evidence	Certainty* of hazard in humans
Dental fluorosis (a physiological effect, not simply cosmetic)	Extensive clinical and epidemiological studies on humans	Certain; widely acknowledged by dental researchers
Skeletal fluorosis, which involves calcification of bones and joints and abnormal bone growth	Large body of clinical and a few epidemiological studies in naturally fluoridated areas of India, China, Persian Gulf and Africa†	Certain, but ignored by many pro-fluoridationists; early stages of disease almost indistinguishable from arthritis
Hip and other bone fractures, mostly in older people	Majority of 20 epidemiological studies on humans in several countries	Very probable; pro-fluoridationists focus on the few studies that show no effect
Hypersensitivity reactions	One epidemiological (double blind) and large body of clinical studies (blind)	Observed in about 1% of population
Brain damage with corresponding decrease in IQ	Animal pathologies plus animal and human behavioural experiments	Possible
Genetic mutations and chromosome aberrations	Animal and <i>in vitro</i> experiments	Possible

\* The present author's assessment. For an extensive and intensive referenced review of the scientific literature and bibliography and risks and alleged benefits of fluoridation, see [www.fluoridealert.org](http://www.fluoridealert.org) and [www.SLweb.org](http://www.SLweb.org).

† Cases of skeletal fluorosis have been reported when fluoride concentrations in drinking water are as low as 0.7 ppm, a fact that is even acknowledged by the pro-fluoridation National Health and Medical Research Council, but denied by many other promoters of fluoridation. Many cases of skeletal fluorosis have been reported in the refereed medical literature for communities with fluoride concentrations below 2.5 ppm.

have been conducted for 1 ppm fluoridated drinking water.

- Most studies claiming large benefits for fluoridation are poorly designed in terms of choice of test and control populations (in cases where there are controls), examiner bias (blind studies are rare) and the failure to consider the effects of diet and poverty, which are the main factors determining prevalence of dental caries.
- Several major studies conducted by pro-fluoridationists find negligible benefits in permanent teeth.<sup>7,8</sup>

### **Fluoride: a protected toxic chemical**

A key principle of ecologically sustainable development is the precautionary principle:

Where there are risks of serious or irreversible environmental (and health) damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental (and health) degradation [my parentheses].

In toxicology an expression of this precautionary approach is the fundamental principle of protecting those members of the population who are at greatest risk. To do this, toxicology generally requires that average exposure levels to chemicals be a factor of 100 below levels known to cause chronic health damage. A factor of 10 allows for the large variation in individual sensitivities and another factor of 10 allows for the wide range in daily doses received from a fixed concentration. Typical daily fluoride doses in fluoridated areas are generally in the range 1.5–6.5 mg. There are large groups of the population that may ingest high daily doses, e.g. athletes, outdoor workers, those with 'high-thirst' diseases such as

diabetes insipidus, those with kidney damage,<sup>9</sup> and infants bottle-fed on milk formula reconstituted with fluoridated water – these infants receive 100–200 times the daily dose ingested by breast-fed infants.

Not only have fluorides used in dental public health been allowed to escape the fundamental principle of toxicology, but also they seem to have bypassed Australia's regulatory/assessment net for chemicals, since they fall into the 'existing chemicals' category of the Australian National Industrial Chemicals Notification and Assessment Scheme (NICNAS).

Finally, fluorides have escaped two fundamental principles of medical ethics as applied to medications. The first of these is the principle of informed consent to medication. Fluoride is used to treat people and so is a medication. Contrary to the false impression created by some health and dental authorities, there is no scientific evidence supporting the notion that fluoride at a daily dose of several milligrams per day is a nutrient – indeed, there are many communities around the world with much lower fluoride intakes who have excellent teeth. Those who provide medications have a duty to inform 'patients' of the risks and benefits of the medications. Yet people are being misled by pro-fluoridationists that:

- the ingestion of 1 ppm fluoridated water is highly effective in reducing dental caries (when the mechanism of action is 'predominantly topical')
- ingestion of 1 ppm fluoride is safe for everyone.

By delivering this unnecessary medication through the public water supply, health authorities are in effect making the ingestion of an additional 1.5–6.5 mg/day or more fluoride above background levels compulsory for those members of the community who cannot afford

water purifiers based on ion-exchange resins, reverse osmosis or distillation. This is another failure to conform to the medical ethics of informed consent. Furthermore, the delivery of a medication with an uncontrolled dose goes against the medical ethical principle that medications should be prescribed individually, taking account of the patient's age, sex, body weight and exposure to other sources of the medication.

With these violations of ethical principles and the failure to apply proper regulatory and assessment processes for 'existing' chemicals, fluoride is appropriately called 'the protected pollutant'.

#### Failure to apply the scientific method

No matter how much evidence of fluoridation hazards is put forward, the standard response by proponents of fluoridation is to chant that fluoride is 'safe and effective'. Instead of addressing the scientific questions, pro-fluoridationists generally refer to their long list of endorsements, substituting a marketing exercise for science. As a matter of policy, pro-fluoridation officials and professionals refuse invitations to participate in conferences, scientific seminars and public debates where an anti-fluoridation case is presented.

For example, on 6 May 2003 the US Environmental Protection Authority sponsored a scientific 'debate' on fluoridation at the EPA's annual conference in Washington DC. The 'anti' case was presented by Dr Paul Connett, Professor of Chemistry at St Lawrence University, USA. But, despite sending invitations to many prominent pro-fluoridation medical doctors and dentists and their professional organisations, the EPA could find no one willing to present the 'pro' case at the 'debate'. In Australia, NSW Health, Vic Health and the Australian Dental Association have also refused to debate Professor Connett and other scientists who are opponents of fluoridation. This suggests that proponents are maintaining fluoridation by political power and influence rather than by open, rational, scientific argument and evidence.

This hypothesis is supported by an examination of pro-fluoridation literature,<sup>10</sup> which is based on:

- unsubstantiated and unscientific claims that fluoridation is 'beyond scientific debate'
- numerous endorsements from professional and government bodies that have never conducted their own objective assessments of the issue
- misleading and/or false 'spin', such as referring to fluoride as 'natural' and a 'nutrient'; using phrases such as 'fluoride deficiency' (there is no such condition) and 'controlled fluoridation' (when the daily dose cannot be controlled); and creating the false impression that fluoridation is only making a small adjustment to the natural fluoride concentration in drinking water (when typically it increases the concentration 5–10 times)
- misrepresenting and attacking the scientific/professional credibility and integrity of individual opponents.

This approach draws upon the image of science without its substance. It is time that the fluoridation issue is brought before an unbiased, public, scientific scrutiny. Socially responsible chemists and biochemists could play an important role in identifying and explaining to the public the key chemical reactions of fluoride and insisting upon proper scientific evaluation of its health and environmental impacts. More generally, all 'existing' chemicals on the NICNAS list require safety assessments as part of any ecologically sustainable development process.

#### References and notes

- 1 However, in well water in some parts of the world, e.g. India and China, the natural fluoride concentrations may reach several ppm or more.
- 2 Emsley J. *et al.* An unexpectedly strong hydrogen bond: Ab initio calculations and spectroscopic studies of amide-fluoride systems. *J. Am. Chem. Soc.* 1981, **103**, 24–8.
- 3 Diesendorf M. A kick in the teeth for scientific debate. *Australasian Science* 2003, **24**(8), 35–7. A referenced version may be downloaded from [www.sustainabilitycentre.com.au](http://www.sustainabilitycentre.com.au) – go to Popular Articles.
- 4 Centers for Disease Control. Recommendations for using fluoride to prevent and control dental caries in the United States. *Mortality and Morbidity Weekly Review* 2001, **50**(RR14), 1–42.
- 5 Centers for Disease Control. Achievements in public health, 1900–1999: fluoridation of drinking water to prevent dental caries. *Mortality and Morbidity Weekly Review* 1999, **48**(41), 933–40.
- 6 Diesendorf M. The mystery of declining tooth decay. *Nature* 1986, **322**, 125–9.
- 7 Brunelle J.A., Carlos J.P. Recent trends in dental caries in U.S. children and the effect of water fluoridation. *J. Dental Research* 1990, **69** (special edition), 723–7.
- 8 Armfield J.M., Spencer A.J. Consumption of non-public water: implications for children's caries experience. *Community Dent. Oral Epidemiol.* 2004, **32**, 283–96.
- 9 Healthy kidneys excrete about 50% of ingested fluoride. The rest accumulates in the bones and a few other organs, such as the pineal gland.
- 10 For example Mid North Coast Area Health Service 2004, *Fluoride Facts*, A4 page, NSW Health.

### CERTIFIED REFERENCE MATERIALS

Reference Materials sourced from over 130 suppliers worldwide covering all the major suppliers, for example, BAS, NIST, SABS, CANMET, BCR, NRC of C, IAEA.

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