COLIN J. RIX AND **DIANA C. DONOHUE**

Commentary on the case of fluoride

Colin J. Rix and Diana C. Donohue comment on Mark Diesendorf's perspective on fluoridation (see page 14).

Mark Diesendorf proposes that chemicals in food and drink, in this instance fluoride, are a threat to both the natural environment and social equity. The article fails to acknowledge the considerable number of studies in recent years, several of them pivotal in terms of study design and adjustment for confounding factors, that have rigorously examined the effects of fluoride on human health. There is now overwhelming evidence that adding trace amounts of fluoride to water supplies has led to a dramatic decrease in the incidence of dental caries, particularly in children.[1]

The strength and vitality of a society are vested in the opportunity for balanced and informed debate on issues of public concern, especially if it challenges an established practice or long-held belief. Society's attitudes change, and new research can clarify issues of concern or point to other unforeseen consequences, as exemplified in our attitude to smoking and asbestos products, and the recent withdrawal of the anti-arthritic drug Vioxx® from the Australian market.

Governments are charged with caring for the society they represent in a benign and cost-effective manner, and they have an obligation to consider carefully any recommendations from their expert committees prior to implementation. Public health programs are a balance between the benefit to society and the infringement of an individual's rights, as illustrated by the examples of vaccines and chest X-rays. Similarly, water fluoridation provides dental health benefits to society in a cost-effective and socially equitable manner. It can be compared to the addition of vitamin D to margarine to maintain healthy bones, or folic acid to cereals to reduce the risk of pregnant women bearing children with spina bifida.

Fluoride occurs naturally in soil, water, plants and animals in trace quantities. It is the thirteenth most abundant element in the earth's crust. Fluoride compounds in air rank third in air pollutants. Fluoride occurs naturally in all water supplies, mostly at levels too low to protect teeth from dental decay. It is present to some extent in most foods and drink. It is impossible to devise a fluoride-free diet. Fluoride is not classified as a medication by medical authorities.

In those communities with naturally fluoridated water it was observed that fluoride protected against tooth decay and that in some areas dental fluorosis occurred. Subsequent observation and experiment found that 1 ppm fluoride gave a balance between reduced decay and a minimal risk of mild dental fluorosis.

Fluoride is absorbed mostly from the stomach and small intestine and about half is then excreted in the urine. Most of the retained fluoride is taken up by bones and teeth. Very small amounts circulate in the blood and saliva and there is virtually none in other body tissues.

The fluoride content of teeth reflects the biologically available fluoride at the time of tooth formation. After this time fluoride levels remain constant, except for the outermost layer of the enamel. This is important for two reasons. First, it means that at the time of tooth development only what was available after absorption can form part of the tooth structure. Once the tooth is formed no more fluoride is incorporated into it, but this does not apply to the enamel surface. Second, for enamel protection the tooth surface needs continuous bathing with fluoride.

Decay was previously thought to be prevented by incorporation of fluoride into the tooth enamel during formation. It is now known that decay prevention occurs on the surface of the tooth. Fluoride can be leached from the tooth surface as liquids pass over it, so it is important to protect erupted teeth by maintaining fluoride levels at the enamel surface. The presence of fluoride in plaque and saliva aids remineralisation of the enamel lesions before cavities become permanent. In this way it benefits both children and adults.

In erupted teeth, there is no doubt that the action of fluoride is essentially topical 'surface ion exchange', whereby the fluoride ion exchanges with the isostructural hydroxide ion present in the hydroxyapatite biomineral in teeth (and bone) to strengthen enamel and promote the remineralisation of microcavities, which form on teeth every day. Certainly, ingestion leads to systemically absorbed fluoride, which can bathe the teeth as it is recycled in saliva – this not only ensures protection of the enamel, but also acts on cementum at the

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base of the tooth as gum shrinkage occurs.

In older people, fluoride helps reduce the incidence of root surface decay as the surface becomes exposed to oral bacteria when the gums shrink. It also reduces the incidence of decay of the crown of the tooth. This is significant for the health of adults and, especially, aged people, because the single most important factor in maintaining health of the aged is good dental health for adequate nutrition.

The health concerns raised in the present article regarding fluorosis, bone effects, mental acuity etc. have been reviewed extensively and exhaustively in our recent document[1] commissioned by the NHMRC (1999). In that instance, an independent expert group of toxicologists, chemists, pharmacologists and epidemiologists concluded, on the basis of current information, that there were no unforeseen health consequences that might arise from fluoride exposure at the nominal 1 ppm level in drinking water.

The evidence indicated that the current levels of fluoride added to drinking water supplies throughout Australia did not need altering (from the current 1.1 ppm in temperate Hobart to 0.6 ppm in subtropical Darwin, allowing for different water intake depending on climate). Since then, several other groups have reported extensive studies and made similar conclusions based on new evidence.[2]

The author's interpretation of the negative health effects of fluoride listed in Table 1 of the article (page 15) is at odds with the numerous peer-reviewed journal articles in the literature. References to websites are of little value unless their validity can be established by independent peer review. It should also be noted that the NHMRC review *The Effectiveness of Water Fluoridation*[3] explicitly examined the author's claims about fluoride, as has Spencer[4] in an extensive response to a later review by the author[5] of fluoridation and its effects.

It is public knowledge that fluoride, like any other chemical, including vitamins and iron tablets, is a poison at high doses. The fatal dose for a 70 kg adult is equivalent to drinking about 2500 litres of optimally fluoridated water. Toxic effects may occur at moderate levels of exposure. Skeletal fluorosis occurs in countries where the natural concentration of fluoride in water is more than 8 ppm and exposure is for 20 years or more. This is not a public health issue in Australia.

Fluoride is indeed deposited in the bones, and gradually accumulates with time, but epidemiological studies do not indicate any causal association between fluoride and bone disorders. Studies of the effect of exposure to fluoridation on fracture incidence have shown fracture incidence to decrease, increase or remain unaffected. These results are inconsistent because the studies were poorly designed, using small numbers of people, different methods and differing fluoride levels. They did not always consider confounding factors such as age, diet, weight, physical activity, hormone therapy, alcohol use and smoking, all of which are well recognised influences on the risk of fractures.

The better designed studies suggest water fluoridated at optimal levels has a protective effect against hip fracture. Several well-designed studies after 1998 have similarly found either no increase in the risk of hip fracture or a reduced risk with optimally fluoridated drinking water.

Dental fluorosis is a defect in the development of tooth enamel. The link between natural levels of fluoride in drinking water and dental fluorosis has been known for over 100 years. Fluorosis occurs at exposures to fluoride above the optimal level. Mildly fluorosed enamel is fully functional and resists acid attack better than enamel from low or optimally fluoridated areas. Dental fluorosis occurs in both fluoridated and non-fluoridated areas. Some overseas studies show the biggest increases in its incidence are in areas of non-fluoridated water supply.

Dental fluorosis is a result of total fluoride absorption from all sources – natural sources, fluoridated water, or inappropriate use of fluoride toothpaste and/or supplements at a young age. It is acknowledged that children should not receive excessive amounts of fluoride, so much so that manufacturers formulate specific toothpaste for children and recommend its use in small amounts, to reduce the risk of mottled enamel. The crucial age for fluoride intake as a risk for dental fluorosis is from 22 to 26 months, the time of development of the permanent front teeth. Adults do not develop dental fluorosis. Dental fluorosis is undesirable but not a threat to health. It is not as disfiguring or disabling as severe tooth decay or missing teeth.

Claims that fluoride is allergenic are not supported. Evidence shows that fluoride is unlikely to produce effects on the immune system. There is strong evidence against suggestions linking Down syndrome to fluoridation. Claims that optimally fluoridated water causes repetitive strain injury (RSI), sudden infant death syndrome (SIDS), diminished intelligence or Alzheimer's disease are unsubstantiated. The Alzheimer's Association itself supports fluoridation to help maintain the dental health of those with dementia.

The assertion that fluoride has 'been largely ignored in Australia as a toxic chemical' is incorrect: fluoride has been subject to considerable and continuing investigations regarding all aspects of human health. It is trite to suggest that fluoride is 'the protected pollutant', since it has undergone intensive scientific scrutiny over many years, and is still considered a benign and efficacious means of preventing tooth decay. In many countries, particularly in Europe, where for technical or other reasons it is not feasible to fluoridate the water supply, table salt or milk are fluoridated.

Indeed, the health effects of fluoride have been reviewed by 'socially responsible chemists and biochemists', and their deliberations and conclusions conveyed to both

the Commonwealth Government, through the NHMRC, and the Victorian Government, in an independent enquiry, through the Department of Human Services.[2,6,7]

In Australia in the 1950s, dental decay in children and adults was uniformly and uncontrollably high across social and demographic boundaries. In 1953, the Tasmanian town of Beaconsfield was the first in Australia to add fluoride to a public water supply. During the 1960s and 1970s, water fluoridation was introduced in most Australian capital cities. Dental decay has since declined in most Australian children to about 10% of what it was in the 1950s. About three quarters of Australians receive the health benefit of living in fluoridated water areas. Dental health in fluoridated areas is significantly better than in non-fluoridated areas. The best available evidence from studies after cessation of water fluoridation demonstrates a subsequent increase in the incidence of dental decay.

Australia has established, centralised and regulated supplies of reticulated water. The fluoridation process and levels in domestic water are monitored regularly to ensure a reliable source in compliance with the Australian Drinking Water Guidelines. The government's peak medical advisory body, the National Health and Medical Research Council, reaffirmed in 1993, and again in 1999, that fluoride concentrations in public water supplies ranging from 0.6 to 1.1 ppm, depending on the climate, are a safe and effective dose of fluoride for dental health.[1]

Water fluoridation has been endorsed by more than 150 public health and scientific organisations,[8] including the Fédération Dentaire Internationale; Irish Forum on Fluoridation; International Association for Dental Research; Ontario Ministry of Health, Canada; UK National Health Service Centre for Reviews and Dissemination, University of York; and WHO.[9]

The British Medical Association, the British Dental Association and the British Fluoridation Society remain convinced that there is no definitive evidence of any adverse risk to human health from water fluoridation, and that introduction of fluoridation in areas of high need would significantly reduce tooth decay and bring the additional benefit of a reduction in the number of general anaesthetics administered to children.

The American Dental Association estimates that '…every dollar spent on putting fluoride in water saves about $80 in dental health costs…'.

In April 1999, the Centers for Disease Control and Prevention stated, 'community water fluoridation ranks with eradication of smallpox and polio as one of the 10 great public health achievements of the 20th century'.

In conclusion, on the basis of the current evidence, it would be remiss of government to deny the community the public health benefits from water fluoridated at the optimal levels.

References

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4 Spencer A.J. New, or biased, evidence on water fluoridation? *Aust. NZ J. Public Health* 1998, **22**, 149–54.

5 Diesendorf M., Colquhoun J., Spittle B.J., Everingham D.N., Clutterbuck F.W. New evidence on fluoridation. *Aust. NZ J. Public Health* 1997, **21**, 187–90.

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