Australian recommendations for water fluoridation (continued)

5. So that people can choose to consume fluoridated water, sodium fluoride should be marketed as a water supplement for addition to non-fluoridated water sources, thereby achieving a fluoride concentration of approximately 1 mg/L.

6. Infant formula nowadays is safe for consumption by infants when reconstituted using fluoridated or non-fluoridated water. (Historically, infant formula was manufactured with a varying but relatively high fluoride content. When reconstituted with fluoridated water and consumed by infants, there was a potential for exposure to relatively high levels of fluoride in relation to body weight. Infant formula now has very low amounts of fluoride. While the workshop did not review information about fluoride content of infant formulas, evidence from Australian population-based studies presented at the workshop revealed no association between consumption of infant formula and levels of dental fluorosis.)

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Fluoride

Water Fluoridation - still the answer

Introduction

The role of fluoride in the prevention of dental caries has been recognised for over 60 years, and fluoridation of public water supplies has been widely adopted in much of Australia over the past 40 years. While community water fluoridation has repeatedly been shown to be safe, economical and effective, some areas of Australia are still not fluoridated.

Fluoride in nature

Fluoride is the 13th most common element in the earth, occurring in rocks, soils and the sea, but also present in animals and plants. The concentration of fluoride found in soils varies from place to place, ranging from 10 to 1,070 parts per million (ppm), with average values between 200 and 300 ppm. In seawater it is found in concentrations ranging from 0.8 to 1.4 ppm. It is also present in almost all fresh groundwater at varying concentrations.

Community water fluoridation

Adjusting the level of fluoride in community water supplies for the purpose of dental caries prevention first occurred in 1945 in the USA. Since then over 100 studies in more than 20 countries have shown that fluoridation reduces dental caries, which explains the high priority given to water fluoridation by public health authorities. Water fluoridation provides the greatest benefit to those who can least afford preventive and restorative dentistry (Slade et al. 1996). In reducing dental decay it reduces the risk of loss of teeth, time away from work or school, and requirements for dental treatment under general anaesthesia. Many millions of people throughout the world now receive water with adjusted fluoride concentrations; this includes about 13.5 million people (approximately 2 in 3) in Australia, with fluoridated water supplies in every capital city except Brisbane.

In February 2008 the Queensland parliament passed a bill to implement water fluoridation across the State.

Optimal fluoride concentration in water

The appropriate concentration of fluoride for public water supplies is the concentration at which maximum caries reduction can be achieved while limiting dental fluorosis to acceptable levels of prevalence and severity. Water consumption directly affects the amount of fluoride ingested daily, and thus the recommended concentration of fluoride in public water supplies is higher in cooler climates, where it is likely that less water is consumed, and lower in the tropics, where larger volumes of water are consumed per person. Australia has a temperate climate for which concentrations ranging from 0.6 ppm in Darwin to 1.1 ppm in Hobart have been confirmed by the National Health and Medical Research Council (NHMRC) as safe and effective. Minor variations around these figures are quite acceptable; however, some loss of efficacy in preventing caries can be expected if levels fall to below 0.5 ppm.

Who benefits from fluoride?

The belief that only children benefit from fluoride is outdated. While fluoride incorporated into forming tooth enamel before eruption helps to prevent later decay, the presence of fluoride at the surfaces of teeth after eruption has been shown to be of equal importance (Fejerskov et al. 1981; Beltran & Burt 1988). Thus, the beneficial effect of fluoride is available to dentate individuals of all ages.

This is fortunate because research is indicating that the incidence of dental caries can be high among adults, in particular older adults (Hand et al. 1988). Exposed root surfaces in older people are more likely to decay, and the risk may be even greater in those whose salivary flow has diminished. Research also indicates that fluoride may have benefits in reducing the incidence of secondary or recurrent caries activity (Kidd et al. 1992), which is thought to be responsible for approximately half of all fillings placed in adults. The use of fluoride to prevent dental caries is therefore beneficial to young children and adults alike, with even greater importance for people at higher risk of dental caries.

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Studies of Australian Army recruits by Hopcraft et al. (2003, 2006) reported the benefits of lifetime exposure to fluoridated water on the oral health of adults. A meta-analysis of three studies of adults by Griffin et al. (2007) supported the same conclusion. The recent Australian 2004–06 National Survey of Adult Oral Health (Slade et al. 2007) supports the finding that the benefits of exposure to fluoride in water and in toothpaste are carried into adulthood.

Anticaries mechanisms of fluoride

Two mechanisms have been proposed to explain the influence of fluoride on caries activity—the 'pre-eruptive' mechanism and the 'post-eruptive' mechanism.

Is water fluoridation safe?

The 2007 NHMRC 'Systematic review of the efficacy and safety of fluoridation' stated that "water fluoridation at levels aimed at preventing dental caries had little effect on fracture risk", "no association with increased cancer risk" and that "studies did not indicate an increased risk of other adverse events".

The NHMRC recommended that "Fluoridation of drinking water remains the most effective and socially equitable means of achieving community-wide exposure to the caries prevention effects of fluoride. It is recommended that water be fluoridated in the target range of 0.6 to 1.1 mg/L, depending on climate, to balance reduction of dental caries and occurrence of dental fluorosis".

The United States Centers for Disease Control and Prevention (1999) refer to fluoridation of water supplies as safe and effective in the prevention of dental caries, nominating water fluoridation as one of the top 10 greatest public health achievements of the 20th century.

Claims have been made that fluoridation causes or contributes to cancer, skeletal fluorosis, Down's Syndrome, renal disease, allergic conditions and fluoride hypersensitivities, repetition strain injury, mutagenicity, enzyme dysfunction and bone disorders. These claims have not been substantiated by experimental studies or epidemiological analyses.

In past studies the Australian recommended levels of fluoride in water have been found to be associated with mild fluorosis in 11% of children and more severe fluorosis in less than 2% (Do 2007). Over the decade 1990–2000 (Riordan 2002) fluorosis levels have halved in Australian children, probably due to the implementation of recommendations in relation to discretionary fluoride use (Riordan 2002).

All sources of fluoride can act through both pre-eruptive and post-eruptive mechanisms. For example, fluoridated water provides systemic contact to unerupted teeth after it is absorbed and circulated, and topical contact to erupted teeth as it passes through the oral cavity.

Pre-eruptive mechanism

Fluoride is ingested and incorporated into the enamel during mineralisation of the developing tooth, favouring the crystallisation of larger and more regular fluorapatite

> ***....the beneficial effect of fluoride is available to dentate individuals of all ages.***

crystals, which are less susceptible to acid dissolution than hydroxyapaptite. Recent studies have confirmed the importance of pre-eruptive fluoride exposure (Singh et al. 2003). Fluoride is incorporated into the enamel before eruption (during early childhood), providing some protective benefit. This pre-eruptive exposure seems particularly important for the occlusal surfaces (Singh et al. 2004).

Post-eruptive mechanism

Fluoride also works through a post-eruptive mechanism where the maintenance of a low fluoride concentration at the tooth/plaque interface confers caries prevention benefits throughout life. Because it is consumed daily, drinking water is the most effective way to maintain exposure to fluoride throughout life (Fejerskov et al. 1981, Beltran & Burt 1988).

Post-eruptively, fluoride also affects plaque and saliva. Acid produced by acidogenic bacteria releases fluoride from the dental plaque, which is then taken up by demineralised enamel to form a more stable enamel structure (Rolla et al. 1990). Other mechanisms include:

- inhibiting demineralisation by lowering the critical pH for dissolution of tooth enamel (van Dijk et al. 1979)
- enhancing remineralisation by lowering the energy needed for reformation of apatite crystals or calcium fluoride (Margolis 1990)
- inhibiting acid formation by micro-organisms involved in caries formation (Hamilton 1990)
- interfering with the growth and metabolism of these same micro-organisms at higher fluoride concentrations (Hamilton 1990).

Fluoride prevents dental caries on both smooth surfaces and occlusal surfaces of teeth. Water fluoridation reduces caries by approximately 38% on approximal surfaces and 26% on occlusal surfaces; however, in the study of Australian Army recruits the reduction in smooth surface caries was not significant (Hopcraft et al. 2006).

The timing of the exposure to fluoride is also important, with exposure during crown completion being effective irrespective of exposure at maturation and post-eruption (Singh et al. 2007).

Substitution of non-public water for fluoridated water

The widespread use of non-fluoridated bottled water for drinking will dilute the effects of water fluoridation, as will the use of tank water for drinking and cooking. A study by Armfield et al. (2004) found that caries in the deciduous dentition increased markedly with increasing use of non-fluoridated water. The results for the permanent dentition were less clear. Use of fluoridated public water in bottles should be encouraged, as should the use of bottled water containing fluoride where it is available.

Importance of water fluoridation in relation to other fluoride vehicles

The most widely used fluoride product is toothpaste. Over 95% of all toothpastes sold in Australia contain fluoride, and the habit of brushing teeth with a toothpaste at least daily is almost universal. Widely available yet less frequently used are fluoride mouthrinses and gels. These sources of fluoride vary in the extent to which they prevent caries in populations. This is largely because of differences in the proportion of the population using each form of fluoride and compliance of individuals with any special guidelines on use.

The original studies on water fluoridation estimated a 50–60% reduction in dental caries among US children. Studies of the effects of water fluoridation since the introduction and widespread use of fluoride toothpastes and, to a lesser extent, mouthrinses have found that the benefit of water fluoridation is additive to other forms of fluoride use. The effect contributed by water fluoridation is estimated to be a reduction in dental caries of between 20% and 40%.

In regard to water filters, those which use osmosis remove fluoride from the water and should be discouraged. However, carbon filters retain fluoride in the water and are the preferred filter for oral health.

Recommendations for non-fluoridated areas

For many years it was recommended that children living in non-fluoridated areas take fluoride supplements in the form of tablets, drops or chewable lozenges. However, evidence suggests that supplements increase the risk factor for dental fluorosis (Spencer et al. 2008, Pendrys et al. 1989) because they can cause a spike in the fluoride concentration in the blood, which can cause damage to the forming enamel. Therefore the revised/current guidelines for use of fluorides in Australia, guideline number 12 (ARCPOH 2006), state that fluoride supplements in the form of drops or chewable/swallowable tablets should not be used. The current recommendation to use fluoride supplements to make fluoridated water (e.g. by adding 1 mg of fluoride to 1 litre of non-fluoridated water—see recommendation 5 below) which is then used for drinking, alleviates this problem.

Australian recommendations for water fluoridation

In 2004 a workshop was held in Adelaide to develop some recommendations for fluoride use in Australia. Those relevant to water fluoridation are listed below.

1. Water fluoridation should be continued as it remains an effective, efficient, socially equitable and safe population approach to the prevention of caries in Australia.

2. Water fluoridation should be extended, with support from all levels of Government, to as many people as possible living in non-fluoridated areas of Australia.

3. The level of fluoride in the water supply should be within the range 0.6–1.1 mg/L, with variation within that range according to the mean maximum daily temperature.

4. So that people can choose to consume bottled or filtered waters containing fluoride, manufacturers should be encouraged to market bottled water containing approximately 1.0 mg/L fluoride and water filters that do not remove fluoride. An integral part of this guideline is that all bottled water and water filters should be labelled to indicate the concentration of fluoride in water consumed or resulting from the use of such products.