Community

Water

Fluoridation

The Irish Dental Association 2001

The following report represents the position of the Irish Dental Association on community water fluoridation. It is based primarily on the results of national and international research conducted by scientists whose findings have been published in internationally recognised peer reviewed professional journals. It also reflects the position of nearly 100 international organisations which recognise the public health benefits of community water fluoridation for preventing dental decay. These include the World Health Organisation, the Federation Dentaire Internationale, the American Dental Association, the American Medical Association and the International Association for Dental Research.

The dental profession in Ireland aims via interventionist and preventive measures to control and reduce dental decay in the Irish population. The evidence presented in this report indicates that community water fluoridation is safe and effective in preventing dental decay in both children and adults. Furthermore, it benefits all affected people regardless of their social or economic status. Therefore, based on the current state of knowledge, the Irish Dental Association endorses fluoridation of community water supplies. It also recognises, however, that the safety and efficacy of this public health measure needs to be continuously evaluated and current practices adjusted if the weight of available evidence so indicates.

This report is presented under 7 sections:

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4. Safety Issues Relating To Fluoridation.
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This report was prepared by the Scientific Committee of the Irish Dental Association. The members of this committee are:

Dr Martin Houlihan, (Chairman).
Dr Frank Burke.
Dr Frank Quinn.
Prof. Brian O'Connell.
Dr Tiernan O'Brien.

Introduction

Following the observation of reduced dental decay being associated with certain enamel discoloration by McKay and Black[1] Churchill determined the discoloration, or "mottling", was associated with exceptionally high levels of the common mineral, fluoride. This "mottled" enamel is now termed severe fluorosis[2]. Observational and epidemiological studies by Dean in the 1930's and 1940's indicated a strong inverse relationship between dental caries and the natural levels of water fluoride. His later studies indicated that the optimal water concentration of fluoride was approximately 1 part per million, producing near maximum caries protection and low prevalence of generally mild fluorosis (evident as small white opacities)[3].

Clinical intervention studies have shown that artificial fluoridation of community water supplies, to the level of 0.7-1 ppm, produces a similar dramatic caries reduction and low incidence of fluorosis as that which occurs with water supplies which have naturally occurring fluoride of a similar concentration[4]. The reduction in dental caries reported by many of these early studies is in the region of 50-70% for 13-15 year olds[5,6,7].

The effects of fluoride on teeth are either systemic (during tooth development) or topical (contact with the enamel surface). Fluoridation acts via both routes but it is now believed that the topical effect is of greatest significance in caries reduction. Furthermore, the greater the frequency of exposure, the greater the topical effect[8].

Since the introduction of community fluoridation schemes in the United States of America some 50 years ago, extensive and ongoing research has been undertaken into the cost-effectiveness of this preventive measure. The cost of such schemes varies with the size of the community served, with the greatest cost-effectiveness being evident in larger schemes. The mean cost of community water fluoridation has been estimated at 50 cents per person per year for US residents (American Dental Association Statement on Water Fluoridation, 1999). Direct savings from fluoridation and fluoride containing products were estimated to be in the region of $39 billion for the period of 1979-1989[9]. This CDC report, however, does not take into account such indirect costs as work and school absences, or pain and suffering, as a result of dental caries.

Community water fluoridation started in the Irish Republic in 1964 and has been associated with a marked caries reduction in all age groups[10]. Of particular importance is that water fluoridation benefits all socio-economic and age groups. Previous studies have indicated that lower socio-economic groups have a higher incidence of dental caries and that older individuals are retaining their teeth for longer, thereby, developing different patterns of dental caries. Both groups have reduced access to dental treatment. The US National Health and Nutrition Survey[11] has verified a continued caries reduction amongst all socio-economic and racial groups, largely due to the effects of fluoride.

In the last 15-20 years, there has been a reduction in caries incidence in non-fluoridated regions, both in Ireland and elsewhere, leading some to question the need for continued fluoridation[2]. This is thought to be due to exposure to other sources of fluoride, particularly toothpastes, and to the "halo effect" of foodstuffs, drinks etc. being manufactured with fluoridated water supplies. There remains, however, a significant additional reduction in caries in fluoridated areas[8]. There are indications that Irish

dietary habits, which includes a high dietary sugar intake, would favour an increase in dental caries should fluoridation be terminated. This has been the experience in similar communities, such as Stanraer, Kilmarnock and Wick in Scotland[12,13,14].

After extensive evaluation of the vast amount of clinical evidence, the US Surgeon General recently stated “community water fluoridation remains one of the great achievements of public health in the 20th century - an inexpensive means of improving oral health which benefits all residents of a community, young and old, rich and poor alike”. It remains the most cost effective and socially equitable means of reducing the incidence of the “silent epidemic” of dental caries in all age groups[15].

Evidence For The Efficacy Of Fluoridation Internationally

Prior to fluoridation of water supplies, children living in naturally fluoridated areas in the United States exhibited lower levels of decay than those living in non-fluoridated areas[16,17]. Fifteen years after the introduction of systemic water fluoridation in Grand Rapids, Michigan, USA, children had 50-63% less decay than those examined prior to fluoridation[5]. After fifteen years of systemic water fluoridation teenagers in Newburgh, New York had 70% less dental decay than teenagers in a comparable city in New York state[6]. When two areas of similar social class distribution, ethnic structure and employment levels in England were compared it was found that the fluoridated community had 40% less decay than the non-fluoridated community[18].

In 1983 two communities in North Wales, Anglesey, which was fluoridated, and Arfon, which was not fluoridated, were compared for caries levels together with changes in caries levels since a previous study in 1974. While caries had declined in both communities, children in Arfon had 45% more decay than children in Anglesey[19]. These findings would seem to indicate a continuing need for fluoridation despite a decline in caries levels[20].

In the United Kingdom it was predicted that water fluoridation would result in a 44% reduction in tooth decay in 5 year-old children. Furthermore, those children in lower socio-economic groups had a reduction of 54%[21]. This implies that children with the greatest dental needs may benefit most from water fluoridation.

Discontinuation of water fluoridation in Wick in Scotland resulted in a 25% increase in decay in permanent teeth and a 40% increase in decay in primary teeth. This demonstrates an increase in decay after the cessation of water fluoridation even in a society where topical fluoride products are available[14]. When water fluoridation was discontinued in Stranraer in Scotland there was an increase of 115% in the mean cost of the treatment of dental decay[22].

Food and drink processed in fluoridated areas can contain optimal levels of fluoride. This food and drink are consumed not only in fluoridated areas but also in non-fluoridated areas. This “halo” effect can result in increased fluoride intake in non-fluoridated areas[23,24]. As a result of this phenomenon the difference between decay rates in fluoridated and non-fluoridated areas has been reduced but is still significant[25]. A recent systematic review commissioned by the UK government included 214 international studies relating to the efficacy of fluoridation. It concluded that water fluoridation was associated with an increased proportion of children without caries and a reduction in the number of teeth affected by caries[26]. This review also found a dose dependant increase in fluorosis.

The proportion of older adults is increasing throughout the Western World. Water fluoridation can also help reduce caries in older adults, especially root caries. When two cities in Ontario, Canada were compared it was found that the fluoridated community had significantly less root caries than the non-fluoridated community[27]. Similarly in Sweden, caries levels were found to be lower in adults in a fluoridated community compared to a non-fluoridated community[28].

Evidence Of The Efficacy Of Fluoridation In Ireland

Evidence of the effect of fluoridation of the water supply in Ireland is available from three sources:

1. Comparison of pre-fluoridation data with post-fluoridation data nationally.
2. Comparison of data from fluoridated areas with non-fluoridated areas nationally.
3. Comparison of data from fluoridated areas in Ireland with non-fluoridated areas internationally.

Pre-fluoridation data is available from a national baseline study conducted during 1961 – 1963[29]. This can be readily compared with post-fluoridation data from a national survey of children's dental health commissioned in 1984[30] and with data from studies conducted in 1992, 1993, and 1995 in the Western[31], Eastern[32], and North Eastern Health Boards[33]. Data on adult dental health is available from a national survey conducted in 1990 – 1991[34]. The results of these studies have been reviewed in the public dental health literature[35].

The mean DMFT, (decayed, missing and filled teeth), for five year olds decreased from 5.6 in 1961 – 1963 (pre-fluoridation) to 1.8 in 1984 for residents of fluoridated areas. For eight year olds, the decrease was from 1.7 to 0.6, for twelve year olds from 4.7 to 2.6 and for fifteen year olds from 8.2 to 4.1. Similar improvements were seen for the percent of children with no caries i.e.: in five year olds 15% were caries free in 1961 – 1963 compared with 52% in 1984. Residents of non-fluoridated communities, however, also displayed an improvement in mean DMFT and in the percent of children caries free over the same time period. In five year olds resident in non-fluoridated areas, mean DMFT decreased from 5.6 in 1961 – 1963 to 3.0 in 1984, (compared with 1.8 for fluoridated areas), and the percent of children caries free improved from 15% to 38%, (compared with 52% for fluoridated areas.)

From 1961 – 63 to 1984 all age groups displayed a decline in DMFT and an increase in the percent of children caries free, the improvements being greatest in residents of fluoridated areas. For eight, twelve and fifteen year olds, the differences in mean DMFT scores in 1984 between fluoridated and non-fluoridated groups were 40%, 21% and 24% respectively in favour of fluoridated areas[35].

Data from the 1992 – 1995 health board studies reveals a further continued improvement in dental health over time but the differences between data from residents of fluoridated and non-fluoridated areas, still clearly favours fluoridation. In the Western Health Board in 1992 the mean DMFT for fluoridated versus non-fluoridated areas respectively were as follows: five year olds 1.0 versus 2.1, eight year olds 0.4 versus 0.5, twelve year olds 1.6 versus 2.2. In the North Eastern Health Board in 1995 similar mean DMFT data were: five year olds 1.2 versus 1.8, eight year olds 0.4 versus 0.5, twelve year olds 1.3 versus 1.6. No non-fluoridated data is available from the 1993 Eastern Health Board study.

Data from the adult survey[34] also allow comparisons of dental health of residents of fluoridated and non-fluoridated areas. Outcome measures included mean DMFT, mean number of teeth present, % people with more than 20 teeth and % people edentulous. For all outcome measures and for all age groups, oral health was better in those who

were residents of fluoridated communities. Comparing 25 to 34 year olds in fluoridated versus non-fluoridated areas respectively, mean DMFT was 14.7 versus 16.9, mean number of teeth present was 26.1 versus 22.9, % adults with more than 20 teeth was 95% versus 77.2% and % adults edentulous was 0% versus 3.3%. The incidence of root caries was also lower in all age groups over 25 years in residents of fluoridated areas compared to residents of non-fluoridated areas.

For a variety of geographical and social reasons most people in Ireland are exposed to fluoridated water in some form even if they reside in a non-fluoridated area. For this reason, it is difficult to obtain data from a truly non-fluoridated control group. In 1992, Blinkhorn et al[36] reported on the oral health of 12 year olds in Dublin, (fluoridated in 1964), and Glasgow, (non-fluoridated). Dublin had similar levels of caries to Glasgow in 1961 prior to water fluoridation. The Mean DMFT in Dublin 12 year olds reported in 1992 was 1.48 compared to 2.70 for Glasgow. 43% of Dublin children studied were caries free compared to only 24% of children in Glasgow. These differences were similar for DMFS data, (decayed, missing and filled surfaces) - Dublin 2.69, Glasgow 4.85. Interestingly, however, a later study in 1994 revealed superior dental health for the same age group in Edinburgh and North London, neither of which were fluoridated, when compared to Dublin[37]. Socio-economic factors, use of fluoridated dentifrices, school rinsing programmes and naturally occurring fluoride in the water supply of some districts may explain some of these differences but the data reveals a mean DMFT of 1.27 for London and 1.39 for Edinburgh compared to 1.48 for Dublin.

These data illustrate the difficulty of obtaining true test and true control groups without other confounding variables. In the Irish context, comparison with non-fluoridated areas in Northern Ireland may be a more valid comparison than with, for example, North London. Also, data, from previously fluoridated areas that cease fluoridation would, if it becomes available, throw further light on this subject. Nonetheless, evidence available to date reveals that while the prevalence of dental caries in Ireland in both fluoridated and non-fluoridated areas is in decline, the effect of fluoridation on dental health in Ireland appears to be measurably beneficial.

Safety Issues Relating To Fluoridation

The issue of the safety of water fluoridation is of prime importance. Concern has been expressed about possible links between water fluoridation and bone fracture, osteoporosis, various forms of cancer, renal disease and other conditions. Such concerns must be continuously evaluated and addressed fully in order to advise the public about the risk-benefit ratio of fluoride. Safety concerns should be assessed in light of the best scientific evidence available.

A recent report by the U.S. Surgeon General found that "community water fluoridation is an effective, safe, and ideal public health measure"[15]. Since the inception of water fluoridation many authoritative studies have been performed in different countries investigating the effects of fluoridation on human health. These data have been reviewed on many occasions by scientists, government committees, commissions, and major health organisations[38]. The weight of scientific evidence clearly indicates that water fluoridation is safe and effective.

Unfortunately, claims that water fluoridation may cause human disease often receive sensational but uncritical coverage in the media. The data relating to the safety or risk of water fluoridation are generally derived from ecological studies of populations[39]. The proper design and analysis of ecological studies is highly technical, and so the conclusions are often open to different interpretations[40]. Indeed, due to the inherent weakness of ecological studies they rarely can show causality, and should not be used to do so[41].

For example, studies have been published that show water fluoridation has no effect on the incidence of hip fracture[42,43] increases the incidence[44,45,46] and decreases the incidence [47,48]. Indeed, studies by the same author showed that following the introduction of water fluoridation there was an increased[46] or decreased[48] incidence of hip fracture. A review by the U.S. National Institutes of Health in 1991 concluded that there was no basis for changing public health policy on water fluoridation because of concerns over hip fracture or bone health[49]. A recent systematic review by the UK Department of Health found that there was no clear association of hip (or other bone) fracture with water fluoridation[26].

A number of ecological studies have also suggested a link between water fluoridation and various malignancies. However the Knox report in 1985 and other reviews in the U.S. and Britain[50,51] have not substantiated these links and have demonstrated some of the flaws with the original studies. Also, despite the widespread introduction of community water fluoridation and the subsequent monitoring of cancer rates, there has not been a scientifically validated association between water fluoridation and cancer. For example, it has been suggested that water fluoridation may be related to the development of osteosarcoma[52]. However, other studies with different methodologies have not been able to reproduce this relationship[53,54,55].

Numerous studies in different countries, including the United States, Japan, the United Kingdom, Canada and Australia, have failed to show an association between water fluoridation and cancer. The U.S. Environmental Protection Agency stated in 1997 that "the weight of evidence from more than 50 epidemiological studies does not support the hypothesis of an association between fluoride exposure and increased cancer risk in

humans”[56]. The U.S. National Cancer Institute investigated the relationship between water fluoridation and cancer by examining cancer death records and case records over 36 years. The researchers found no indication of an increased cancer risk associated with water fluoridation[38]. The American Cancer Society stated that “Scientific studies show no connection between cancer rates in humans and adding fluoride to water”[57]. The UK review of fluoridation in 2000 also found no association of water fluoride with malignancy or other adverse effects[26].

It must be emphasised that fluoride, like other minerals, should be used and consumed properly. A report by the National Academy of Sciences for the U.S. Environmental Protection Agency affirmed that a ceiling of 4 ppm for naturally occurring fluoride in drinking water was “appropriate as an interim standard”[58]. The report noted that the currently allowed fluoride levels in water do not pose a risk for cancer, kidney failure or bone disease. In Ireland, a recent review of water fluoridation and public health by the Royal College of Physicians stated "In conclusion, the data available to date strongly support the continuation of the current water fluoridation policies. The epidemiological evidence that fluoride protects against dental caries is overwhelming. Concerns about adverse effects other than dental fluorosis have not been substantiated”. Nonetheless, the recent UK review of water fluoridation points out that by today’s standards very little high quality research into the safety or efficacy of fluoridation has taken place, and suggested that any future research should be carried out with the best possible methodology[26].

Dental Fluorosis

Some degree of dental fluorosis will accompany the maintenance of a low level of fluoride in the mouth. Numerous studies have indicated a strong association between water fluoridation and the proportion of the population with dental fluorosis[26].

Dental fluorosis is caused by a disruption in enamel formation which occurs during tooth development in early childhood[59]. Enamel formation of permanent teeth, other than wisdom teeth, occurs from the age of birth until approximately five years of age. After tooth enamel is completely formed, dental fluorosis cannot develop even if excessive fluoride is ingested[60]. Older children and adults are not at risk for dental fluorosis.

The clinical spectrum of dental fluorosis varies from symmetrical whitish areas on teeth, (very mild), to mild, moderate and severe fluorosis as manifest by extensive brownish discoloration and varying degrees of pitting of enamel. Very mild to mild fluorosis is not readily apparent to the casual observer but moderate and severe forms constitute a significant aesthetic change in tooth colour and surface irregularities.

The early trials of fluoridation established that a fluoride concentration of 1ppm resulted in a 50% reduction in caries prevalence while the prevalence of enamel fluorosis remained low and was generally of a mild variety[61,62]. In recent years concerns have been raised about the increased prevalence and severity of dental fluorosis in the U.S[63,64,65]. Mild levels of fluorosis are associated with the ingestion of optimally fluoridated water[66]. Other sources of fluoride have increased the levels of exposure to fluorides including fluoridated toothpaste, bottled water and processed foods[67,66]. In non-fluoridated and optimally fluoridated areas, reports of higher prevalence of dental fluorosis was confined mainly to the milder categories of the condition[65,68].

The prevalence of fluorosis in Irish school children was examined by O'Mullane in 1984[30]. The prevalence of fluorosis was found to be negligible. The prevalence of enamel opacities or fluorosis was similar in children living in fluoridated and non-fluoridated areas. In a recent review of fluorosis trends in Ireland, Whelton et Al reported on the change in prevalence of enamel fluorosis in the Eastern Health Board area for eight and fifteen year olds between 1984 and 1993[69]. Results indicated an increase in the prevalence of 'questionable' fluorosis from 5% to 19% for eight year olds and from 2% to 21% for fifteen year olds. Overall, the results indicate that the prevalence of very mild, mild and moderate grades of fluorosis appear to be increasing. As part of this effect may be due to fluoridated toothpaste it is recommended that prudent use of small (pea sized) quantities of toothpaste along with parental supervision to minimise swallowing, is practised by children. Furthermore, dental fluorosis prevalence should be regularly monitored using indices sensitive enough to detect early changes in enamel, as recommended by WHO[67].

Future Research Strategies on Fluoridation

While there has been extensive research on fluoridation issues are emerging which warrant further research.

The precise molecular and cellular mechanism of the action of fluoride into caries and fluorosis needs to be elucidated. This includes the influence of such factors as genetics, environment, age, nutrition, gender, and drugs on fluoride metabolism (including bioavailability, intake and excretion).

The optimum level of fluoride in the mouth to minimise caries and fluorosis needs to be determined accommodating for individual consumption of systemic fluoride and the potential use of topical fluoride as an adjunct.

The use of biomarkers for the assessment of the body burden of fluoride needs to be developed further including the relationship between caries levels, dental fluorosis, bone fluorosis and fluoride levels in fasting plasma, saliva, dentine, hair and nails.

An internationally validated and accepted benchmark for fluoride analysis from different sample types of body tissues and fluoride from different food and drinks is a prerequisite for comparison of data, transfer of information and establishment of optimum fluoride levels.

The relationship between fluoride consumption and osteoporosis merits further evaluation especially with regard to identifying cultural, environmental, genetic or social factors which may be associated with excess fluoride exposure.

The prevalence and severity of skeletal fluorosis together with standardised methods of diagnosis, prevention and treatment of such a condition should be investigated.

It has been suggested that some elements such as lithium or copper may negate the effects of fluoride while others such as strontium, boron, lithium, molybdenum, selenium, and titanium may enhance the effects of fluoride. Analysis of a combination of any or some of these elements with fluoride on caries would be desirable.

An internationally validated and accepted benchmark for the diagnosis of the occurrence and severity of dental fluorosis is needed. Such a benchmark would also help discriminate dental fluorosis from other dental opacities.

The social and cosmetic influence of dental fluorosis on the general population and the dental profession together with the objective treatment need is required.

Although fluoride has had a significant effect on the general population there is a cohort who are very susceptible to carious attack. Investigation is needed as to why this cohort are resistant to the anti-caries effect of fluoride and how preventive measures can be targeted at this group.

Diagnosis of dental caries in a fluoridated area can be a clinical challenge and when caries does develop it can have progressed substantially before it is diagnosed. Consequently diagnostic aids, which increase the diagnosis of caries would be desirable.

Conclusion.

As a profession dedicated to the maintenance of optimal dental health and the prevention of disease, the Irish Dental Association recognises the huge benefits associated with water fluoridation in this context. As the evidence to date has failed to identify any significant safety issues with regard to fluoridation of the water supply, other than the increased incidence of mild to moderate fluorosis in some cases, the evidence for its efficacy is substantial and the Association would strongly support the continuation of the current water fluoridation policies. Some would argue that depriving those most at risk of caries of the proven benefits of water fluoridation is unjust while others would argue that mass medication is an infringement of their rights to autonomy. This ethical issue will no doubt continue to be debated for some time and there is no doubt that valid arguments can be put forward for both sides of the debate.

As mentioned previously, it is critical that the safety and efficacy of this policy continues to be closely monitored and that the current practices are kept under constant review based on the most up to date information available at any time.

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