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Executive Summary

Introduction

The Forum on Fluoridation, established by Mr Micheál Martin, TD, Minister for Health and Children, in May 2000 was given the task of performing the first major review of water fluoridation since its introduction in Ireland in 1964.

The overall objective of the Forum was to review the fluoridation of public piped water supplies in Ireland and the associated programme of research and then to make recommendations to the Minister for Health and Children.

The resulting Report is a comprehensive review which aims to inform members of the public, legislators and health professionals about the benefits and risks of water fluoridation for human health.

Structure of the Report

The report provides the reader with an informative account of the entire fluoridation issue. It covers the topics listed below and includes an introduction by the Chairman and an acknowledgement of the assistance the Forum received from numerous organisations, professional bodies, individual experts and the general public.

- Issues of public concern
- Dental decay and the methods employed in its prevention and control
- The delivery of oral health care services to the Irish population along with international comparisons
- An account of the history of water fluoridation from both an Irish and international perspective
- A description of fluoridation status on a worldwide basis
- The public water supply system, which includes an account of the various standards with which treatment processes must comply
- Legislation governing the drinking water quality in general and the specific requirements for the monitoring of fluoride
- The nature of the hydrofluorosilicic acid used in water fluoridation, the issue of quality control and the method by which the appropriate amount of chemical is added to the drinking water
- The benefits and risks of water fluoridation with particular reference to dental fluorosis
- Methods to control dental fluorosis, including risk factors for fluorosis and strategies for reducing its prevalence and severity
- Ethical and legal issues in the form of a series of questions and answers and through a commentary by an ethicist on the topic of water fluoridation
- The programme of oral health research currently underway in Ireland and details of a number of individual projects
- A large number of appendices, found at the back of the report, include such items as: the methodology and detailed findings of the public consultation process; the Health (Fluoridation of Water Supplies) Act and relevant regulations; a summary of the manufacturing process of hydrofluorosilicic acid; the water treatment process and a number of other relevant pieces of information which if included in the main body of the report might interfere with the smooth flow of information, but which nonetheless are essential in an accurate account of the water fluoridation issue
- A bibliography that includes all documents referred to in the body of the report.

Conclusions and Recommendations

Introduction

At its final plenary meeting on 25 October 2001, the members of the Forum discussed the conclusions to be drawn from the information and data gathered and assessed over the previous fourteen months. With the terms of reference kept to the fore, members were requested by the Chairman to give their views on the future of water fluoridation in Ireland. Specifically, their responses were sought to three questions:

- Has water fluoridation improved the oral health of the Irish population?
- Is there scientific evidence that water fluoridation at a level of 1 part per million (mg /l) endangers human health?
- What recommendations would you make?

The members present duly expressed their views on these three questions. Some of those who were unable to attend the meeting subsequently submitted their views, and the recommendations and conclusions presented below are based on the views of the majority of members of the Forum. In addition, a number of members gave the opinions of the particular organisation or professional body they represented rather than their own view.

Overall Conclusions

- Water fluoridation has been very effective in improving the oral health of the Irish population, especially of children, but also of adults and the elderly.
- The best available and most reliable scientific evidence indicates that at the maximum permitted level of fluoride in drinking water at 1 part per million, human health is not adversely affected.
- Dental fluorosis (a form of discolouration of the tooth enamel) is a well- recognised condition and an indicator of overall fluoride absorption, whether from natural sources, fluoridated water or the inappropriate use of fluoride toothpaste at a young age. There is evidence that the prevalence of dental fluorosis is increasing in Ireland.

Recommendations

The recommendations of the Forum on water fluoridation are intended to assist health care providers, public health officials, policy makers and the public in achieving maximum protection against dental decay and in minimising the occurrence of dental fluorosis.

In making its recommendations the Forum has been cognisant of two recent strategy documents: *Quality and Fairness: A Health System for You* (Health Strategy 2001) and *Making Knowledge Work for Health* (Health Research Strategy 2001).

- *Quality and Fairness: A Health System for You* outlines a number of measures that will underpin an evidence-based approach to the planning, monitoring and delivery of health care on a national level.
- *Making Knowledge Work for Health* outlines a research and development function for the health boards/Authority, based on a partnership approach with an international dimension.

It is envisaged that the forthcoming National Health Information Strategy will support processes and procedures to ensure easier access and best use of available health information, including the exploitation of modern information and communications technology.

The precise manner in which some of the Forum's recommendations will be implemented may depend on the structures and processes arising from these Strategy documents.

For example, one of the functions of the proposed Health Information and Quality Authority is to oversee health technology assessment. As water fluoridation is a well-established health technology, future assessments of it may be the remit of this Authority.

The Health Boards Executive (HeBE) provides an important means of enabling the health boards/Authority to operate jointly on matters where a national approach to implementing a programme or service is required. It is envisaged that the HeBE will play a major role in ensuring the consistent delivery of a national water fluoridation programme of the highest standard.

The recommendations are presented under a number of headings which reflect the main issues covered in the Forum's report. Reference to the items from the above strategy documents will be made as appropriate.

Recommendation 1

Policy Aspects of Water Fluoridation

- The fluoridation of piped public water supplies should continue as a public health measure, subject to the other recommendations contained in this report.
- In the light of the best available scientific evidence, the Fluoridation of Water Supplies Regulations, 1965 should be amended to redefine the optimal level of fluoride in drinking water from the present level (0.8 to 1.0 ppm) to between 0.6 and 0.8 ppm, with a target value of 0.7 ppm.
- The amended Regulations should reflect advances in the technology of fluoride monitoring and testing and also the most recent international specifications for the quality of the products used in the fluoridation process.
- An Expert Body should be established to implement the recommendations of the Forum and to advise the Minister for Health and Children on an ongoing basis on all aspects of fluoride and its delivery methods as an established health technology.

Against a background of exposure to multiple sources of fluoride and changes in the rates of dental decay and dental fluorosis on both a population and individual level, it is considered appropriate to redefine the optimal level of fluoride in the Irish drinking water, taking account of these altered circumstances.

In the light of both international and Irish research which shows that there is an increasing occurrence of dental fluorosis, the Forum recommends the lowering of the fluoride level in drinking water to a range of 0.6 to 0.8 ppm, with a target of 0.7 ppm.

In the opinion of the Forum this level of fluoride would be sufficient, along with the continued use of fluoride toothpaste, to maintain meaningful reductions in dental decay rates while reducing the occurrence of dental fluorosis.

The validity of this recommendation should be further assessed when the results of the National Survey of Children's Dental Health and the Food Safety Authority of Ireland's study of infant feeding are available.

The Expert Body should have multi disciplinary representation, including dentistry, public health medicine, toxicology, engineering, management, environment and the public, and should draw upon national and international expertise, including that of the oral health care industry. It is envisaged that this Expert Body may be subsumed into the Health Information and Quality Authority proposed in *Quality and Fairness: A Health System for You*.

Recommendation 2

Technical Aspects of Water Fluoridation

- Guidelines/codes of practice and audit processes should be developed to support ongoing quality assurance of all aspects of the water fluoridation process and should take account of results of both Irish and international research.
- External audit procedures of existing fluoridation plants should be put in place to monitor the performance of fluoridation plants and should be part of the specification of new plants. Audit results should be included in annual reports on water fluoridation produced by relevant fluoride monitoring committees.
- The standards and quality of each fluoridation plant should be assessed and decisions made as to the appropriateness of the continued use of inefficient plants.
- Fluoride monitoring and analytical and reporting procedures should be updated to reflect modern technologies and to facilitate timely reporting of all drinking water fluoride levels. These results should be made available in an appropriate format so that compliance with regulations can be monitored. These results should be freely available for public scrutiny.
- Raw water should be checked for fluoride levels before fluoridation takes place in compliance with the current Regulations.
- The Eastern Regional Health Authority, currently responsible for purchasing the fluoridating products on behalf of the country's health boards, should ensure compliance with the amended Regulations specifying the quality standards of the products used in the fluoridation process.

The Expert Body or its equivalent function in the Health Information and Quality Authority in collaboration with the Health Boards Executive (HeBE) may have a key role in the implementation of the above recommendations.

Recommendation 3

Fluoride Toothpaste

- The Forum recommends the continued use of fluoride toothpaste in fluoridated and non-fluoridated areas because of the additive benefit from the combination of fluoridated water and fluoride toothpaste.
- Parents should be advised not to use toothpaste when brushing their children's teeth until the age of 2 years. Prior to this age parents can brush their children's teeth with a toothbrush and tap water. Professional advice on the use of fluoride toothpaste should be sought where a child below 2 years of age is considered to be at high risk of developing dental decay.
- Parents should supervise children aged 2 to 7 years when brushing their teeth and should ensure that only a small pea-sized amount of fluoride toothpaste is used and that swallowing of the paste is avoided (see photograph).



- Paediatric toothpastes with low concentrations of fluoride require further research before the Forum can recommend their use.
- Guidelines for the use of oral health care products in childhood should be developed for use by all involved in advising members of the public on health care matters. The Expert Body will play a key role in the development of these guidelines.

Recommendation 4

Oral Health Care Industry

The Forum acknowledges the contribution of the oral health care industry in improving the oral health of the population. The Forum suggests that the industry should take a number of steps to reduce the risk of inappropriate use of fluoridated products by consumers, including the following:

- Labelling of fluoride products in a manner which is better understood by the general population and especially by those with low levels of literacy or visual impairment
- The use of clear and understandable instructions on all fluoride product labels, in particular symbols/pictures to describe the appropriate amount of toothpaste to be used by children
- The provision of child resistant containers for mouth rinses and fluoride supplements to prevent inappropriate ingestion of these products by children.

Recommendation 5

Infant Formula

- Infant formula should continue to be reconstituted with boiled tap water in accordance with manufacturers' instructions. Alternatively, ready-to-feed formula can be used.
- The use of bottled water to reconstitute infant formula is not recommended unless the labelling indicates its suitability for such use.

These recommendations are made taking account of Recommendation 3 regarding the appropriate use of fluoride containing toothpaste for young children and Recommendation 1 regarding the reduction in the level of fluoride in drinking water.

Recommendation 6

Fluoride Research

- All future research undertaken should be consistent with the research philosophy as outlined in the Health Research Strategy.
- The Expert Body should prioritise designated research in areas relevant to fluoride, and appropriate funding should be made available.
- Ongoing research related to fluoride should continue to be evaluated by the proposed Expert Body and expanded to deal with new emerging issues.
- Research related to fluoride should include the collection of relevant data on general health.
- In view of the acknowledged importance on a worldwide basis of research in the area of fluoride and oral health, the health board research programmes currently in place should continue and be further developed to augment the world body of information on fluoride for the benefit of all.
- The current 10-year cycle of adult and child dental health surveys should continue. In addition a rolling programme of oral health surveys every second year for a selected age group of children should be implemented.

In addition to research on fluoride, eating practices and other oral health related behaviours, the new programme of research should include any areas of research related to general health considered appropriate by the proposed Expert Body. This research should complement that already available from other well-established population health surveillance systems.

Recommendation 7

Education, Information and Public Participation

The Forum's report is a comprehensive review of water fluoridation aimed at informing the public, legislators and health professionals about the benefits and risks of water fluoridation for human health.

As a response to calls for greater democratic, transparent and participatory policy processes, and in line with *Quality and Fairness: A Health System for You* which highlights the need to support improvements in the availability and quality of health information, it is essential to provide the general public and special interest groups with factual information on all aspects of water fluoridation including a full account of the work of the Forum.

This will require the development of a communications strategy to ensure that an informed debate takes place at all levels, i.e. the political arena, the media and on a community basis.

A multi-tiered approach will provide accessible and appropriate information for the public as a whole and for specific special interest groups. A number of approaches is set out below:

- Media analysis and discussion in both the national and regional press to ensure widespread dissemination of the findings of the Forum
- Further information from the report itself and from the Forum's website
- National and local radio and television coverage to add to this information flow
- Short video presentation of the main issues, accompanied by explanatory leaflets made available to schools and local libraries, for example
- Regional public meetings with a panel of multi disciplinary experts available to present information and to respond to questions and concerns expressed by the general public or by any special interest group. Such meetings, for example could be convened at the request of local interest groups – local authorities, community groups or consumer organisations
- Following completion of this exercise, surveys or other methods undertaken to measure the public response to the findings and recommendations of the Forum in order to help inform policy makers and legislators about public attitudes to water fluoridation.

The aim of these initiatives will firstly be to increase public awareness of water fluoridation and its context and secondly to elicit public attitudes and values. The Expert Body in consultation with the Dental Health Foundation and other appropriate bodies will determine the means whereby these public participation initiatives will be organised.

Recommendation 8

Public Health and Professional Practice

- Oral health as an integral part of general health should be included in the overall provision of health care and in the design of health promotion programmes and initiatives.

Issues which have arisen in the debate on fluoride may have caused some public and professional concern with regard to the benefits and risks of water fluoridation. From a public health point of view all involved in the public health profession should become familiar with the findings of this Forum and be able to give balanced and scientific information to the public.

As adults and the elderly benefit from water fluoridation, the role of fluoride in preventing dental decay in this population group needs to be promoted. Health care professionals should therefore deliver advice on oral health along with advice on general health care matters. The maintenance of good oral health will have a major impact on the overall quality of life of the elderly.

Additional Views and Conclusions

The Consumers' Association of Ireland (CAI) took a neutral stance on the question of the benefits and risks of water fluoridation. The CAI council had voted that consumers should have choice in this issue and that as mandatory water fluoridation does not offer choice, the CAI opposes the continuation of water fluoridation. It is the recommendation of the Consumers' Association of Ireland that the Government should now cease adding fluoridating chemicals to the piped drinking water.

The Irish Doctors' Environmental Association (IDEA) likewise adopted a neutral stance on the benefits of water fluoridation, and expressed its opposition to the continuation of the fluoridation of drinking water supplies. The Association has concerns regarding the addition of fluoride to the water supply, on the grounds of unknown dosage, particularly with regard to infants. It also has concerns regarding contaminants and the possible interaction of fluoride with other drugs. The Association believes that the ingestion of fluoride should be a matter of choice, and that dental decay is best prevented by dietary measures and improved dental hygiene.

The Public Consultation Process

The level of public interest in fluoridation was among the factors which influenced the setting-up of the Forum. This body accordingly gave a high priority to ascertaining in some detail the views of the public and to addressing the concerns identified. As a precursor to this, the Report initially considers the topics of 'risk' and 'hazard' and discusses briefly the differences between the two.

In order to determine how the public perceived the risks of fluoridation, a consultation exercise (see Chapter 2), was carried out in which submissions and comments were invited from interested persons and parties. The methodology used was generally acceptable to the public and, more importantly, was successfully responded to although there were criticisms of some perceived shortcomings of the procedure.

The Report considers these criticisms as valid and explains the time constraints which governed them. It also addresses the broader issue of criticism of the Forum in terms of members being 'pro' or 'anti' fluoridation in their approach to the business of the Forum, and it states unequivocally that such partial considerations did not arise during the proceedings, and that it was only in the framing of the recommendations that Forum members expressed views for or against fluoridation.

While the substantive issues raised by the public to the Forum are addressed in Chapter 2, it was evident that there were some serious misconceptions with regard to aspects of fluoridation which had to be addressed at the outset. Not to adopt this approach would have quite probably resulted in further misunderstandings and also confusion for the reader.

Accordingly, this initial chapter addresses in particular the origins of the fluoride used in Ireland and the very contentious subject of the chemical composition of the additive. Appendices to the Report cover both matters. The chapter concludes by explaining that the much commented-upon matter of objectionable tastes in drinking water arises from the confusion of chlorination with fluoridation, and that there are no taste considerations associated with the addition of fluoride at the dosages applied.

Analysis of the Submissions and Consultation Responses

The introduction to this chapter sets out the limitations of the consultation procedure and stresses the differences between it and the controlled survey by a research firm commissioned by the Dental Health Foundation Ireland. However, it also details the high level of response – over 1,000 individual submissions from members of the public - and emphasises the great value to the Forum of the information provided.

The responses came in two general forms: firstly, as concise views on two key topics, and secondly, by way of comments under a variety of headings. The former were very easily analysed and indicated:

- 1 **Approval of fluoridation 8.6%; Disapproval 89.0%; No view 2.4%**
- 2 **Approval of alternative provision of fluoride 29.2%; Disapproval 50.5%; No view 20.3%.**

The latter, being of their nature discursive, were much less straightforward to evaluate, but detailed analyses of each individual submission enabled the preparation of a list of issues and themes which exercised the minds of the public to a greater or lesser degree. This list was invaluable to the Forum in highlighting the issues to be addressed in the main body of the Report, and in covering both principal and peripheral aspects of fluoridation.

The Forum did not attempt to rank or weight the issues raised in terms of their apparent ‘importance’ - the fact that an issue was raised, even by a handful of respondents, made it deserving of due consideration. While the full listing of issues raised is considered in Chapter 2 of the Report, and in an accompanying Appendix, the following may be mentioned here as among those most frequently mentioned by respondents:

- Anger or displeasure over perceived involuntary mass medication of the public
- Concerns over origins of and chemical contaminants in fluoride additive
- Fear of involuntary intake of excess fluoride from multiple sources
- Great concern over lack of choice by consumer to use/avoid fluoride
- Perception that Ireland is virtually unique in fluoridating drinking water
- Widespread perception that many medical ailments are due to fluoride.

These themes (and many others raised) are addressed in succeeding chapters of the Report.

Chapter 2 then summarises the findings of the rigorously controlled survey referred to above and carried out by Drury Research. This investigation concluded that among the public as a whole there was a modest level of concern about fluoride in drinking water and that fluoridation was not a major issue. The heightened level of concern emanating from the submissions to the Forum is due to the fact that respondents to the latter had either specific concerns and/or a much greater knowledge about fluoridation than the average member of the public at large.

The chapter concludes by considering briefly the submission of views and comments by individual local authorities, health boards and professional bodies (also the topic of Appendix 6).

3 Dental Decay

The aim of this chapter is to describe the process of dental decay, the cost of the condition, in both monetary and human terms, the risk factors for the development of decay, in particular sugar consumption, and the measurement and prevalence of decay in Ireland.

Decay Process

Dental decay or dental caries is an infectious disease that affects most people in developed countries. Bacteria in dental plaque react with sugary foods to form acids, which in turn dissolve the tooth enamel. It is a dynamic process with decay formation happening alongside tooth repair. Prolonged periods of frequent consumption of sugary foods, combined with poor oral hygiene, will tip the balance in favour of decay and cavity formation results. When the balance tips in favour of repair, through reduced frequency of consumption of sugary foods and better oral hygiene, including availability of fluoride in the saliva, cavity formation is arrested.

The following photographs show normal healthy teeth and decayed teeth.



Healthy Teeth



Decayed Teeth



Decayed Teeth

Cost of Dental Decay

Dental decay has decreased in the developed world over recent years. However, in Ireland, the frequent consumption of sugary drinks and foods especially by children has resulted in the Irish population continuing to be at a particularly high risk. This risk is greatest in certain sections of the community, with 60-80% of the decay being seen in just 20% of the child population who tend to be from the less well-off sections of society.

While everyone is potentially susceptible to dental decay, children are particularly at risk, especially during the first years following the appearance of teeth in their mouths. As fillings do not last indefinitely, if childhood prevention does not work, adults are committed to a lifetime of repairing and replacing fillings. The total annual non-capital spending on primary care dental services in Ireland is estimated to be in the region of €127 million, over €100 million of which is spent on treating the effects of dental decay.

Certain members of society, as a result of either physical or intellectual disability, are unable to look after their teeth and require regular extensive dental treatments. Due to their disabilities these treatments quite often require the use of general anaesthesia, which is never without risk. There is a small but significant mortality (death-rate) associated with dental treatment carried out under general anaesthesia in Ireland and the United Kingdom. In Ireland in 2000, 4,300 children under 16 years of age received dental treatment under general anaesthesia.

Measurement of Dental Decay

Dental decay is measured using the DMFT index, which involves counting the number of decayed, missing and filled teeth. When comparing decay rates both between and within countries over time, a number of factors influencing oral health must be taken into account, which include preventive practices, health funding and access to dental care, dietary habits, the pattern of sugar consumption and socio-economic status.

Dental caries surveys have been carried out in Ireland on a regular basis since 1952, prior to and following the introduction of water fluoridation. In any health survey it is important to be able to make comparisons between an exposed and an unexposed group, i.e. in the case of dental decay the consumption of fluoridated water. **Health board surveys conducted since 1984 have all consistently shown that children who have been lifetime residents of fluoridated communities have considerably lower decay levels than those resident in non-fluoridated communities.**

This occurred even though the non-fluoridated areas have some of the benefits of fluoride through drinks etc manufactured in fluoridated areas. Children resident in Northern Ireland where water supplies are not fluoridated and where, as in the Republic of Ireland, fluoride toothpaste was introduced in the early 1970s, form a better control group.

A number of surveys comparing dental decay in children in both jurisdictions demonstrated the marked difference in childhood dental decay. In 1963 the average DMFT was 2.0 in 8-year-old children in Northern Ireland and 1.5 in the Republic of Ireland (prior to water fluoridation); in 1983 the average DMFT in Northern Ireland was 1.5 compared with 0.6 in the Republic of Ireland (20 years after the introduction of water fluoridation). In 1963 the average DMFT of 15-year-olds was 9.4 in Northern Ireland and was 8.5 in 1983; in the Republic of Ireland the average DMFT was 8.2 amongst 15 year olds in 1963 and fell to 4.1 in 1984 in the same age group. While it is possible that various sociological, dietary and other factors account for part of this difference between Northern Ireland and the Republic of Ireland it is reasonable to suggest that the major contributing factor is the fluoridation of public water supplies.

Currently, national surveys of both children's and adult's dental health, to measure the effectiveness of water fluoridation, are nearing completion and will again allow for further comparisons with Northern Ireland.

Key Conclusions

Dental decay is a dynamic process and fluoride plays a key role in its prevention. The prevalence of dental decay has fallen considerably over the past 40 years in developed countries. A similar picture has emerged in Ireland with greater reductions in fluoridated as opposed to non-fluoridated areas. **The prevalence of dental decay is approximately 30-50% lower in fluoridated areas of the Republic of Ireland compared with non-fluoridated areas in Northern Ireland.**

4

Methods for Controlling Dental Decay

This chapter describes the various methods for the prevention and control of dental decay, on both a community and an individual basis.

Fluorides

Following the discovery that fluoride in drinking water prevented dental decay other forms of fluoride delivery came into use throughout the world. Fluoridation of salt appears to be a reasonable alternative to water fluoridation where water fluoridation is not possible and has been used in a number of countries since the 1950s. The World Health Organisation has outlined requirements for its use. However, nutrition policies in many countries advise a reduction in salt intake in order to prevent raised blood pressure and the associated cardiovascular diseases.

Milk fluoridation as a public health measure is at an early stage of development and has been used in school-based programmes in parts of Bulgaria, China, Russia, Chile and the UK. While results have been encouraging, as it is a school-based programme (maximum 200 days per year) it does not allow for continuous availability of fluoride.

There is convincing laboratory evidence to show that adding fluoride to sugar reduces the decaying effects of sugar on teeth. However, it is too early to assess its potential as a public health measure.

Fluoride tablets/drops were introduced originally for use in non-fluoridated areas. However, they are not widely used or recommended in Ireland at present. The effectiveness of supplements on an individual basis has been inconsistent as compliance with the schedule is challenging.

The widespread use of fluoride toothpaste has been a major contributor to the decline in dental decay. Recent studies show that combinations of water fluoridation and fluoride toothpastes give considerably greater benefit than either when used alone. In Ireland, the use of two sources of fluoride, i.e. fluoridated water and fluoride toothpaste are recommended for population use. However, very young children tend to swallow toothpaste, which is considered an important factor in the increased level of dental fluorosis.

While tooth brushing is a widely used method for plaque removal, for most people it is inefficient and if sugar is consumed frequently plaque will be left for decay to occur. Nowadays, the main purpose of tooth brushing is to introduce fluoride in toothpaste into the mouth, and thus reduce decay rather than just remove the plaque. Other plaque removal techniques can be used such as inter-dental cleaners, dental floss and other techniques such as chemical control, but these have questionable value in community programmes for the control of dental caries.

Currently in Ireland approximately 30,000 children in 500 schools participate in fortnightly fluoride mouth-rinsing programmes, and while these programmes can be almost as effective as water fluoridation, the cost effectiveness is questionable and since they are school-based they are not effective in older age groups. The use of fluoride gels, fluoride varnish, fluoride rinses, slow release fluoride devices, etc. is primarily limited to high-risk individuals and special needs patients.

Fissure Sealants

Fluoride is not particularly effective in controlling dental decay in the pits and fissures of teeth. A technique for sealing these fissures was developed in the 1960/70s. This is a non-invasive (no drilling) procedure and is acceptable to most children. However, as a public health measure major considerations are its cost effectiveness and the identification of those children at risk of developing decay.

Dietary Choice

Recent data indicate that both children and adults engage in almost ongoing consumption of sugary foods and drinks (displacing milk from the diet) throughout the day. This pattern is more marked in the lower socio-economic groups, which also have higher levels of dental decay. Dental health education programmes aimed at such eating patterns have not been successful. Apart from the effect on dental health of the sugars and acidity, the diet is also becoming deficient in calcium and this may result in osteoporosis in later years.

Regular professional dental care will result in improved dental health and has the benefit of individually focused preventive programmes and of early diagnosis of decay and other diseases.

Chewing Gum

Increased salivary flow can lead to a reduction in dental decay and in this regard the use of sugar-free chewing gum has been shown to be effective in dental decay reduction.

Key Conclusions

The only real alternative community delivery method to water fluoridation is salt fluoridation. However, there could be concern around its introduction because of the role of salt in heart disease. Further research is required in the case of milk fluoridation. Fluoride toothpaste is an excellent adjunct to systems aimed at communities. The remaining fluoride alternatives are expensive to deliver, not as effective as community systems, and involve compliance by the public. Dietary and plaque control education programmes on a community basis have not been shown to be effective.

Provision of Oral Health Care Services

Oral health care in Ireland is delivered through a mixture of public and social insurance funded systems delivered by salaried dentists and general dental practitioners on a fee per item basis, together with a core of private practice.

Dental care for children including screening and preventive care is delivered mainly through salaried dentists in health boards.

Community preventive programmes including water fluoridation are administered through health boards. Oral health promotion is delivered through health boards with assistance from the Dental Health Foundation.

Salaried dentists in health boards also deliver dental care for special needs groups with assistance from both dental hospitals and other tertiary care centres.

Monitoring of the oral health status in the population and other oral health services research is carried out by health boards in collaboration with the Oral Health Services Research Centre, University College Cork and Trinity College Dublin.

A limited amount of specialist care is provided through the hospital service.

Private dentists contracted to health boards on a fee per item basis provide dental care for adults over 16 years with medical cards. This scheme is funded centrally by the Department of Health and Children and administered by health boards through the General Medical Services (Payments) Board.

Insured workers receive dental care on a similar basis under a scheme operated by the Department of Social, Community and Family Affairs. This scheme is funded through the social insurance fund. The main difference between the two adult dental schemes is that there is a system of co-payments in the scheme for insured workers.

A limited number of dental procedures is covered by private health insurance.

While great improvements in the dental health of the population has occurred over the past 30 years there are gaps in service delivery for children under 5 years of age, for certain special need groups and for a range of specialist dental services.

A comprehensive evaluation of dental services including oral health surveys will be completed in 2002.

The History of Water Fluoridation

The aim of this chapter is to relate the story of how fluoride was first observed to have decay preventive properties in the early twentieth century, and how an association was made between staining of otherwise healthy teeth and drinking water containing high levels of fluoride. The subsequent scientific studies are described, the results of which resulted in the conclusion that an optimal level of fluoride in the drinking water would prevent and control dental decay, but would cause minimal mottling of teeth. Thus the adjustment of natural fluoride levels in drinking water commenced.

International Context

In 1901, J.M. Eager, an American physician working in a United States Marine Hospital in Naples, Italy, reported a high frequency of enamel defects and stained teeth among the inhabitants of towns near Naples. The following year Dr Frederick S. McKay, a dentist working in Colorado Springs, in the United States, noticed that many of his patients' teeth were stained brown. Dr F.L. Robertson, a dentist in Bauxite, Arkansas, noted the presence of mottled enamel among children after a deep well was dug in 1909 to provide a local water supply. A theory that something in the water was responsible for mottled enamel led local officials to abandon the well in 1927.

H.V. Churchill investigated the possible cause of mottled enamel. In 1930 he used a new analytical method that identified relatively high concentrations of fluoride (13.7 parts per million) in the water of an abandoned well. Subsequent analysis of water from other endemic areas also revealed high concentrations of fluoride, ranging from 2 ppm in Colorado Springs to 12 ppm in Kidder, North Dakota. Similar observations were made in other countries. In the United Kingdom in 1933, Norman Ainsworth observed that children living in Maldon, Essex with 4.5 ppm fluoride in its drinking water had high levels of mottled enamel, when compared with residents of surrounding districts.

Dr H. Trendley Dean, a young dental officer, was appointed to the US Public Health Service in 1931 to pursue full-time research on mottled enamel. Dean and his colleagues undertook major surveys and investigations to describe the geographic distribution of endemic dental fluorosis and subsequently developed a standard of classification of enamel mottling (fluorosis). This classification continues to be known as Dean's Index of Fluorosis and is still a standard tool in the study of dental disease patterns. It describes six ascending levels of increasing fluorosis, ranging from zero (no fluorosis) to five (severe fluorosis).

In 1942, Dean demonstrated that where drinking water supplies had a natural fluoride content of 1 part per million children had substantially less dental decay and a minimum occurrence of mottled enamel. Thus the theory that dental decay could be prevented by adjusting the fluoride level of community water supplies from negligible levels to 1.0–1.2 parts per million was proposed. Following these investigations the United States Public Health Service decided to adjust the fluoride level of the water supplies to obtain a concentration of 1 part per million.

Grand Rapids, Michigan was the first city in which public water was fluoridated and the dental decay in this city was subsequently compared with Muskegon in which the water was not fluoridated. It was found that the addition of fluoride to the drinking water reduced the incidence of dental decay by approximately 50%. This result prompted the rapid adoption of water fluoridation in cities throughout the United States, and as a result dental decay declined rapidly during the second half of the twentieth century. The American Medical Association, the World Health Organisation and other professional and scientific organisations endorsed this public health measure.

Following this, other methods for delivery of fluoride, such as toothpastes, gels, mouth rinses, tablets and drops were developed, based on the knowledge and experience gained from water fluoridation.

Results of studies commenced in 1955 in Kilmarnock, in Anglesey and in Watford in the United Kingdom were in agreement with those of the American studies.

Irish Context

In the 1940s it was generally believed that there was a relationship between poor nutrition and dental decay. The National Nutrition Survey in 1946 was used to investigate this association, and provided the basis for a subsequent study of dental health of Irish children.

In 1951, the Dental Consultative Council, appointed by the Minister for Health to advise him as to how to improve the dental services, recommended that priority treatment should be given to four groups: pupils of national schools, children attending child welfare clinics and expectant mothers, adolescents (14 to 19 years) and adults eligible for treatment under the Public Assistance Act. A recommendation was made as to the number of dentists required to provide this level of care. The Council's recommendations however were not based on any assessment of the size of the dental decay problem in Ireland.

In 1952, the Minister for Health requested the Medical Research Council (MRC) to carry out a survey to determine whether dental health differed throughout the country and whether any differences could be related to the children's nutrition. It was found that dental decay was high in all parts of the country and that there was no relationship between either the domestic circumstances or dietary habits of the children. Children aged 7 to 8 years had on average 7 decayed, missing or filled teeth (DMFT).

It was obvious from this level of decay that the previously recommended number of dentists would not be sufficient to tackle such an enormous public health problem. The small number of dentists employed in the public dental service (73 in 1957) and the fact that the majority of newly qualifying dentists emigrated, influenced the Government in changing its policy towards giving priority treatment to children to the relative neglect of adults.

A change in the manner in which the Department of Health tackled the problem of dental decay occurred in 1953 when Séamus O'Neill was appointed as a full-time Dental Advisor to the Minister for Health. He was responsible for the initiation of public health dentistry in Ireland and for raising awareness of the public health benefits that might result from fluoridating the public water supplies.

Following a 14-month review of the topic, the Fluorine Consultative Council, established by the Minister for Health in 1957, recommended that an increased intake of fluoride would reduce dental decay and that the best means of providing such an intake would be to fluoridate the public water supplies. The Government accepted the Council's recommendations and set about introducing relevant legislation. Debate followed as to the type of legislation required and a decision to make the legislation mandatory rather than enabling was considered the best option by the Minister for Health. This decision was made for the following reasons: firstly the fact that water supply boundaries overlapped in many regions resulting in operational difficulties if one local authority decided to fluoridate the water and an adjacent authority decided not to fluoridate, and secondly it was believed that if the issue to fluoridate was left to the local authorities, the members would have to familiarise themselves with a large amount of scientific evidence without the benefit of appropriate scientific skills.

The Health (Fluoridation of Water Supplies Act) was passed in 1960 and may be seen in Appendix 7. The Act specified how the local authorities should make arrangements to fluoridate the public water supplies. It also set out the duties of the Minister to conduct surveys of aspects of health which he considered desirable and of the duties of health authorities to estimate the level of dental decay in their areas. Accompanying regulations for each local authority area dealt with the technical aspects of fluoridation and the methods by which the fluoride level in the drinking water was to be measured. An example of these regulations may be seen in Appendix 7.

As was specified in the Act, surveys of dental decay commenced in 1961, and while there were variations from place to place the overall results showed uniformly poor dental health. All piped water supplies in the State were analysed and only five of more than 660 supplies were found to contain any significant concentrations of fluoride.

Constitutional Challenge

When it was decided to fluoridate water in areas supplied by the Dublin water authorities, legal proceedings were taken by a Dublin woman, Mrs Gladys Ryan, alleging that the Health (Fluoridation of Water Supplies) Act, 1960, if implemented would result in an infringement of personal and family rights and would be unconstitutional. This objection resulted in the postponement of water fluoridation. Mr Justice John Kenny heard the case in the High Court in 1963 and ruled that the fluoridation of public water supplies in Ireland was not a violation of any of Mrs Ryan's constitutional rights. The case was subsequently appealed to the Supreme Court in 1964 in which the constitutionality of the Health (Fluoridation of Water Supplies) Act was upheld.

Implementation and Evaluation of Water Fluoridation in Ireland

After the Supreme Court's decision, the process of fluoridation went into operation and by the end of 1964, more than 25% of the population of the State were receiving fluoridated piped water. This included the greater Dublin area and the adjacent areas on the east coast. By 1976, 57% of the population received fluoridated piped water. Currently 73% of the Irish population reside in fluoridated communities.

From 1969 onwards, the incidence of decay has been recorded and compared with the findings of the 1961 baseline survey. Six years after the introduction of water fluoridation in the Dublin area, i.e. 1969, a statistically significant reduction in decay rates of 4-year-old (75%), 5-year-old (65%) and 6-year-old (54%) children was observed. Studies carried out in Cork in the 1970s had similar results and showed that the children born before the advent of water fluoridation had also benefited from the measure. This suggested that fluoride was having a topical effect in reducing dental decay in teeth already erupted into the mouth when fluoride was added to the water supplies.

Studies in the late 1970s showed that while the level of dental decay had declined in those living in both fluoridated and non-fluoridated areas, the decline was greatest in fluoridated areas. This may partly be explained by the fact that fluoride toothpastes were first introduced in Ireland in 1970 and sales of these products increased rapidly over the subsequent decade. A further explanation is a phenomenon called the 'Halo effect' of water fluoridation. This occurs as a result of the presence of fluoride in common items of food and drink which are manufactured in the larger fluoridated towns and cities and thereafter distributed widely in surrounding non-fluoridated areas. The fluoride content of these items causes a reduction in dental decay experience, which is noticeable even if not as great as in fluoridated areas.

A National Survey of Children in 1984, and local surveys in different health boards reported in 1991, 1994, 1996, 1998, 2001, revealed similar reductions in decay rates in fluoridated and non-fluoridated areas. In 1990 the first national survey was conducted to measure the effectiveness of water fluoridation among Irish adults. This showed that the dental health was better in those who were residents of fluoridated communities.

Fluoridation Status Worldwide

This chapter looks at the status of fluoridation on a worldwide basis and gives an account of the countries where water fluoridation is the preferred method and those countries where other methods, in particular salt fluoridation, are used. The reasoning behind the method used and the legislation required are discussed.

Water Fluoridation

Approximately 317 million people in 39 countries benefit from artificially fluoridated water and an additional 40 million benefit from water supplies which are naturally fluoridated.

The United States is now 65% fluoridated and will soon reach the low 70s when California's water fluoridation law is implemented. In Australia approximately two-thirds of the population reside in fluoridated areas, while in New Zealand 57% of the population consume fluoridated water. The Japanese Government has recently endorsed water fluoridation. Vietnam commenced water fluoridation in the last 10 years. In South Korea, 39 cities are now fluoridated and 9 others are in the process of installing fluoridation equipment. South Africa has enacted mandatory legislation requiring all water systems to fluoridate.

No country has banned the use of fluoride. Some countries have decided against water fluoridation for practical or political reasons. For example, in France there are over 20,000 separate public water sources, which makes water fluoridation technically difficult. Under these circumstances, other methods of delivery such as fluoridated salt, fluoridated milk, fluoride mouth-rinses and fluoride toothpaste have been employed to deliver fluoride to the population.

Salt Fluoridation

While roughly 13 million Europeans have access to fluoridated water, approximately 50 million EU citizens consume fluoridated salt. Countries which have fluoridated salt on the market include Germany, France, Belgium, Austria, Switzerland and the Czech Republic. No country has banned the use of fluoride.

Public Water Supplies

As background information for the general reader, Chapter 8 provides a concise account of the topic of public water supplies in Ireland — which originate in either ground water or surface water sources. The types of treatment to be given to raw surface waters depend on their quality and are prescribed by National Regulations derived from an EU Directive. In summary, the poorer the quality of the raw water, the more extensive the treatment process.

A table lists the various categories of water supply – public, group with public source, group with private source, private – and gives approximate numbers of households connected to each. The first two categories serve some 1.05 million households, and it is these, which, in the majority of cases, will be fluoridated.

The public water supplies are discussed in more detail and from a consideration of the practical and technical aspects it emerges that it is effectively impossible to apply fluoridation policy at a local level.

Monitoring of Drinking Water

Further background information is presented in Chapter 9, but at rather greater length. This is because of the desire of the public – as expressed in the consultation process outlined in Chapters 1 and 2 – to know more about how their drinking water is assessed for quality, and because of the doubts expressed in regard to the present situation. Again, National Regulations derived from EU Directives govern the quality of drinking water and its assessment in Ireland. The Regulations currently in force date from 1988 but will be superseded as from 1 January 2004 by new provisions adopted in December 2000.

Because of its stable nature – its concentration in water tends not to change – it is most important that fluoride be added in precise, correct amount at the water treatment works. Its addition is a fairly demanding procedure but, in all but the smallest, more basic treatment works, the various sanitary authorities generally apply it efficiently. At the largest treatment works even marginally incorrect fluoride values are rare.

However, in other, smaller plants there have been repeated occurrences of excess fluoride values (though within EU limits, as explained below). These are attributed to a failure to take into account ‘background’ or naturally-occurring levels of fluoride which when added to a ‘correct’ dose have resulted in excess values.

The chapter next addresses the topic of methods of analysis for fluoride. Although normally a specialised aspect which does not merit consideration, the Report makes the important point that the 1960 Fluoridation Act mentions a specific analytical method which was the best available at that time but which, compared to modern techniques, is actually a hindrance to the analyst, and accordingly a change in the law is called for as a matter of some urgency.

The level of fluoride in drinking water is assessed by reference to a ‘quality standard’ – a maximum permissible concentration that should not be exceeded. As the 1960 Act (discussed in depth in other chapters) prescribed an upper limit of 1.0 parts per million (or milligrams per litre) for fluoride in drinking water, that value was carried forward into the 1988 Regulations and is today the legal limit. However, the limit in the EU Directive is 50% greater (1.5 parts per million). The great majority of excess fluoride values recorded in Ireland are in the region of 1.2 parts per million; they are not however above the limit deemed acceptable by the EU.

Finally, the chapter averts to the trace constituents in the fluoride additive and points out that these are subject to the same great dilution as is the fluoride itself. An appendix gives much detail on this.

10 The Application of Fluoride

Because of public concerns about the origins, nature and composition of fluoride additives to drinking water in Ireland the Report deals with the topic in some detail. In addition to the discussion in Chapter 10 there are no fewer than three accompanying appendices which in total present all available relevant data for the reader.

Concern has been expressed about the use of hydrofluorosilicic acid solution as the fluoride additive instead of the powdered sodium fluoride used at the outset. The Report points out that the change – made wherever fluoridation was practised - was made on practical and safety grounds. A liquid additive can be dosed more accurately and, while safety precautions are essential for treatment plant operatives, there are no associated dust problems. In any event, whichever additive is used, it yields the same fluoride ion in water.

Chapter 10 next deals with the hydrofluorosilicic acid used in Ireland, summarising its manufacture in Spain, its transport to Ireland, and the quality controls applied by the importer, on behalf of the health authority, and by the public analyst. Finally, there is a detailed presentation on the dosage rates of the additive (depending on its exact strength) in order to give the approved maximum concentration of 1.0 part per million fluoride in the final drinking water.

11 Benefits and Risks of Water Fluoridation

Health technologies, whether of a therapeutic or procedural nature, necessitate an assessment of their associated benefits and risks. Chapter 11 in the main report deals with this topic in considerable detail. This summary does not attempt to provide the same level of detail but does nonetheless cover the main points and refers the reader to the original chapter for a comprehensive discussion. This summary describes how water fluoridation resulted in reductions in the level of dental decay and then considers the issue of dental fluorosis. It discusses how guidelines for drinking water quality are derived and the various calculations made in setting national standards for the various constituents of water. Toxicity of both an acute and chronic nature is next discussed. The extensive literature on possible adverse health effects from long-term consumption of fluoridated water is reviewed in the main report with a summary of the main points provided in this present document.

Dental Decay and Fluoride

The 'Twenty-One Cities Study' in the United States described the prevalence and severity of dental decay among populations living in communities with differing fluoride levels of naturally occurring fluoride in the drinking water. The level of dental decay was observed to fall sharply as fluoride levels rose to 1.0 ppm. Since then, numerous studies have assessed the caries-preventive effect of water fluoridation both internationally and in Ireland and have been the subject of a number of reviews, which confirmed the effectiveness of water fluoridation.

For example, prior to the introduction of water fluoridation, 12-year-old children, examined in the Western Health Board in the years 1961-1963, were found to have on average 4.2 decayed, missing or filled teeth (DMFT index). In 1984, the corresponding DMFT among lifetime residents of fluoridated communities was 2.3 compared with 3.0 among lifetime residents of non-fluoridated communities. In 1992, a further study in the Western Health Board revealed an average DMFT of 1.6 compared with 2.2 in lifetime residents of non-fluoridated communities. Currently a national survey of children's dental health is in progress and preliminary results will be available towards the end of 2002. One of the main aims of this study is to measure the effectiveness of water fluoridation. This is an all-Ireland survey and includes assessment of the dental health of children in Northern Ireland where the water supplies are not fluoridated.

The effects of fluoride on dental decay are not confined to childhood; benefit in adults has also been demonstrated. The first national survey of adult oral health, conducted in Ireland in 1990, showed that those resident in fluoridated areas had more natural teeth and that a smaller percentage had lost all their teeth than their counterparts in non-fluoridated communities. Also no difference was found in the general health status of residents of fluoridated and non-fluoridated communities. A survey of adult dental health is currently under way and later in 2002 the current oral health status of the Irish adult population will be known.

Risks

While the term 'risk' has been defined in an earlier chapter as the likelihood that a hazard will result in harm, risk evaluation involves considering both the likelihood that a hazard will cause harm and the severity of the harm that is threatened. In the case of fluoride the observation of mottled enamel in populations resident in areas with high concentrations of fluoride in the drinking water prompted dentists to investigate the properties of fluoride in the prevention of dental decay.

Dental Fluorosis

Dental fluorosis is characterised by alteration in the appearance of the tooth ranging from fine white lines (which are difficult to see), to pitting or staining of enamel. Following the identification of fluoride as a cause of mottled enamel, Dean developed a standard of classification of mottling, which describes six levels of fluorosis:

0 = no fluorosis	1 = questionable fluorosis	2 = very mild fluorosis
3 = mild fluorosis	4 = moderate fluorosis	5 = severe fluorosis.

While it is accepted that excessive fluoride intake at crucial times during tooth development is responsible for some fluorosis, it is now acknowledged that inappropriate use of other sources of fluoride, including fluoride toothpaste during infancy and early childhood, is the primary reason for the development of increased fluorosis in the permanent incisor teeth in recent years. While the predominant beneficial effect of fluoride occurs locally in the mouth, the adverse effect, i.e. dental fluorosis, occurs by the systemic route, i.e. as a result of being absorbed into the body.

Dental Fluorosis in Ireland

Both local and national surveys have monitored the prevalence and severity of fluorosis in the Republic of Ireland and have shown that it is increasing. In the Eastern Health Board in 1984, 5% of 8-year-old children had questionable fluorosis and 2% had very mild fluorosis. By 1997, the prevalence of questionable fluorosis in the Eastern Health Board in 12-year-old children was 14%, very mild 6%, mild 3% and moderate 1%. The current study of children's dental health is looking at the level of fluorosis as well as the level of dental decay and will include not only clinical measurement but also photographic records of incisor teeth of large numbers of children in each health board in Ireland and in Northern Ireland. The results of this survey will give a clear indication of the trends in the prevalence of dental fluorosis in Ireland.

General Health Effects

The World Health Organisation plays a major role in developing guidelines for drinking water quality, which are used as a basis for the development of national standards to ensure the safety of drinking water supplies. These guidelines are based on the results of both animal and human research. A detailed account is given in the main report as to the method in which guideline values are calculated.

In summary, a value called the 'no observed adverse effect level' NOAEL, derived from experimental situations or by observation, is divided by an uncertainty factor and then translated into what can be ingested over a lifetime without appreciable health risk. This is called the tolerable daily intake (TDI). The guideline value is then derived by taking account of the body weight, the fraction of the TDI allocated to drinking water and the daily consumption of water, which varies for adults, infants and older children. In the situation where a NOAEL is not available, a LOAEL may be used, which is the 'lowest observed dose or concentration of a substance at which there is a detectable adverse health effect'.

Values for Fluoride

In the case of fluoride the adverse health effect in the definition of the NOAEL is mild fluorosis in permanent teeth and a value has been derived for two age groups:

- For children under 8 years of age, (i.e. those at risk of developing dental fluorosis), it is accepted that the daily intake of fluoride that will not produce mild fluorosis in permanent teeth, is 0.05 mg F / kg body weight / day, with a range of 0.02 to 0.1 mg F/kg/day. The LOAEL is 0.1mg F/kg/day: an intake slightly above this LOAEL for an extended period of time (several months or years) during tooth development is likely to produce dental fluorosis.
- For children over 8 years and for adults (i.e. not at risk of dental fluorosis) a NOAEL of 10mg F/day is considered appropriate. In order to attain that level of exposure large amounts of water and toothpaste would need to be consumed over long periods.

While the appropriate levels of exposure to fluoride are explained in the above text, the amount of fluoride that actually remains in the body is determined by its bio-availability, i.e. the degree to which the fluoride is available to take part in biological processes. Fluoride enters the body by way of the gastrointestinal tract. Roughly 50% will be excreted in the urine during the following 24 hours and most of the remainder will be stored in calcified tissue, i.e. bone and teeth. A balanced state is maintained by the uptake and release of fluoride from bone and teeth. Therefore if the intake of fluoride is either increased or decreased on a long-term basis, the concentrations in bone and teeth would eventually reflect this change.

Acute Toxicity

Acute toxicity is the immediate effect of consuming large doses of fluoride over a short period of time. The resulting effect depends on the amount consumed and the weight of the individual concerned. Obviously a particular dose of fluoride is likely to have more serious consequences in a young child than in an adult. The toxicity of fluoride is usually expressed as the amount consumed per kilogram of body weight. The **probable toxic dose (PTD)** of fluoride is an oral fluoride dose of 5.0 mg/kg body weight and would require the consumption of 50 litres of water fluoridated at 1mg/l (ppm) by a 1-year-old child and of 100 litres by a 5-year-old child in order to result in symptoms of toxicity.

While the possibility of a child being poisoned by fluoride in drinking water is obviously highly unlikely, young children may be at risk of consuming potentially life-threatening doses of fluoride from oral care products, such as fluoride toothpastes and mouth-rinses. While such poisoning is fortunately extremely rare, a standard tube of toothpaste containing about 125 gram of toothpaste, e.g. generally containing approximately 1350-1450 ppm F, may be life-threatening for a one-year-old child if as little as a quarter of it is swallowed. Similar dangers apply with fluoride mouth rinses and tablets. Most of these fluoride products are readily available over the counter and are not sold in child resistant containers.

Chronic Toxicity

Since the introduction of water fluoridation over 50 years ago in the United States, numerous claims of harm arising from the long-term ingestion of low levels of fluoride have been made. Such claims include allergic reactions, cancer, birth defects, genetic disorders and disorders of various organ systems.

In order for such claims to be considered significant, it should first be possible for other independent researchers to repeat the relevant studies and to arrive at similar conclusions. The type of research should be designed so as to rule out bias and results should make sense in the light of other available knowledge. Research results should be published in recognised peer reviewed medical/scientific journals before they may be considered to have scientific value or merit.

In the area of fluoride the medical literature looking at the consumption on a long-term basis of fluoridated water has been reviewed by a large number of well-recognised authoritative bodies and organisations. While the reader may consult the main Forum report to obtain a detailed account of this literature, a summary of the main points of reviews undertaken since 1979 now follows.

Taves 1979

Taves concluded that the data used to support the claims that fluoridation causes adverse effects on human health, including sensitivity reactions, Down's Syndrome and cancer were not convincing.

Knox 1985

A review of studies of cancer rates in relation to fluoridation of water supplies, published in 1985, concluded that there was no evidence that fluoride occurring either naturally in water, or added to water supplies, was capable of inducing cancer, or of increasing the number of cancer deaths. Results to the contrary were in the reviewers' opinion due to errors in data, errors in analytical technique, and errors in scientific logic.

Bucher 1991

Bucher and his colleagues reported that there appeared to be an unclear link between high exposure to fluoridated water and osteosarcoma (a type of bone cancer) in male rats. This link was not observed in female rats or in either male or female mice.

Following the above observation three critical reviews of the literature were published dealing with the risks and benefits of water fluoridation: Kaminsky, the United States Public Health Service Report and the National Research Council report.

Kaminsky 1990

The authors summarised the benefits and risks of fluoride consumption based on the evidence available at the time and concluded that the consumption of fluoridated drinking water can reduce the incidence of dental caries. They acknowledged that decay rates have also fallen in non-fluoridated areas and attributed this to the exposure to fluoride sources other than drinking water.

Whether the occurrence of moderate dental fluorosis in 1 to 2% of the population exposed to fluoride at 1 ppm in drinking water was an actual adverse health effect remained controversial. There was no evidence of skeletal fluorosis in the United States and reports of crippling skeletal fluorosis associated with low concentrations of fluoride in tropical countries was attributed to other dietary factors.

United States Public Health Services Report

This report concluded that there was no detectable risk of cancer, birth defects, including Down's Syndrome, in humans associated with the consumption of optimally fluoridated water. While the prevalence of dental fluorosis in the USA was higher than in the 1940s, there was disagreement about whether dental fluorosis should be considered a toxic effect. On the other hand skeletal fluorosis was not considered to be a public health problem in the USA.

National Research Council 1993

The National Research Council concluded that the US Environmental Protection Agency (EPA) maximum contaminant level of fluoride at 4 mg /litre was appropriate as an interim standard, but that further research in the areas of fluoride intake, dental fluorosis, bone strength, fractures and carcinogenicity was required.

In 1999, the Ministry of Health in Ontario, Canada undertook a further review of the literature published between 1994 and 1999. The main principle underlying this review was that dental public health interventions, particularly those aimed at total populations, must make a significant contribution to the oral health - related quality of life of the population and avoid risks which may outweigh the benefits.

Recommendations were made in the context of the Canadian situation where the rate of dental decay in children is very low and where there is no significant difference between decay rates in children living in fluoridated and in non-fluoridated areas. These recommendations include the following:

- An assessment of the balance between reductions in dental decay and increases in dental fluorosis should be undertaken in communities with low decay rates.
- Fluoridating water to 0.5–0.6 ppm may be adequate in terms of achieving reductions in dental decay.
- As water fluoridation is a total population strategy, its benefits to the population as a whole and not just children need to be documented.
- Research also needs to be undertaken to determine what level of dental fluorosis is acceptable to the public.

In 2000 the University of Florida reviewed the fluoride literature and recommended further research into total exposure to fluoride, into fluoride and bone and into the effects other ions may have on the manner in which fluoride acts.

York Review

A 'Systematic Review of Public Water Fluoridation' published by the NHS Centre for Reviews and Dissemination in the University of York in 2000, is the most up-to-date expert scientific review of fluoride and health. The review is available on the following website: www.york.ac.uk/inst/crd/fluores.htm

The review concluded that while the best available evidence suggests that fluoridation reduces dental decay, this should be considered together with the increased prevalence of dental fluorosis. There was no clear evidence of other potential adverse effects. Those commissioning future research were advised to learn from methodological limitations of previous research on the topic in order to improve the quality of the existing evidence base.

Fluoride and Bone Health

Concerns have been raised about an association between fluoride and osteoporosis and rates of bone fracture. Several ecological studies have found that rates of hip fracture are higher in communities with fluoridated drinking water compared with communities without fluoridation. These studies however have not controlled for several factors known to be associated with rates of fracture, including the use of oestrogen, smoking and body weight.

Epidemiological studies on the other hand have shown that long-term exposure to fluoride does not have an adverse effect on bone strength, bone mineral density or fracture incidence. The development and validation of a method of tracking and marking fluoride in bone is now regarded as essential in order to further study this issue. It is the opinion of some researchers that fluoride may turn out to be a cost-effective method of reducing the incidence of hip fracture and that a method of marking fluoride would assist in researching this idea further.

12 Controlling Dental Fluorosis

Based on the assessment of risk, as discussed in Chapter 11, there is no clear scientific evidence of adverse general health effects resulting from the fluoridation of public water supplies. However, a recognised and long-acknowledged side effect of fluoride is dental fluorosis.

Chapter 12 identifies the risk factors for dental fluorosis and outlines the strategies which may be adopted for reducing the prevalence of fluorosis in Ireland. Like the summary of Chapter 11 above, no attempt is made here to deal in detail with this complex issue and the reader is referred to the main report for a comprehensive discussion of the topic.

Risk Factors for Dental Fluorosis

In an assessment of the risk factors of dental fluorosis the upper incisor teeth are used as a reference marker, so that prevention or occurrence of fluorosis in these teeth indicates the situation in all the teeth. The most critical period for developing fluorosis on the permanent central incisors has been variously estimated to be between 22 and 25 months of age. However, excessive fluoride ingestion during this time may be associated with an increased risk of fluorosis in the primary teeth. In the main body of the report all the risk factors are dealt with first and then the strategies for their control are discussed. In this summary each risk factor will be dealt with and directly followed by a strategy for its control.

Fluoridated Drinking Water

Technical problems in smaller water treatment plants may, as a result of difficulties maintaining the optimal level of fluoride in the water, expose the public to fluoride levels over and above the optimal upper limit of 1 ppm.

Control Strategy

- To avoid the risk of over-exposure it may be necessary to suspend fluoridation of some small public water supplies.
- It has been postulated that levels as low as 0.6 ppm would achieve approximately the same reduction in the prevalence of dental decay as a level of 1 ppm. In Ireland in 2001, against a background of exposure to multiple sources of fluoride and changes in the rates of dental decay and dental fluorosis, on both a population and an individual level, it is considered appropriate to redefine the optimal level of fluoride, taking into account these altered circumstances.

Infant Formula

Research has shown that the use of infant formula reconstituted with fluoridated water is regarded as a risk factor for dental fluorosis of the anterior permanent teeth when the formula is consumed for a period of thirteen to twenty-four months. The overall contribution to the development of fluorosis attributable to infant formula, in Ireland, is currently the subject of a risk assessment analysis being undertaken by the Food Safety Authority of Ireland (FSAI).

This assessment will take into account the recommendation concerning the downward adjustment of the fluoride content in public water supplies and the resultant reduction in dental fluorosis that can reasonably be expected. It will also take account of the bioavailability of fluoride ingested by infants. If appropriate, changes to the recommendations regarding appropriate infant feeding practices will be made in the light of the findings of this risk assessment.

The current national survey of children's dental health and other studies in progress will also examine the association between infant feeding practices and dental fluorosis. The results of these studies will be available in 2002.

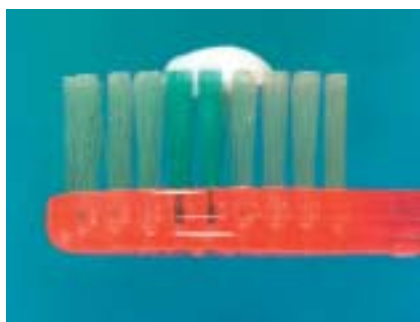
There is no evidence that the ingestion of infant formula reconstituted with fluoridated water is a risk factor for any condition other than dental fluorosis.

Control Strategy

- An increase in the rate of breast-feeding in this country would contribute significantly to a reduction of the risk of dental fluorosis. However, it is recognised that the use of formula feeding will continue to be the preferred choice for many parents.
- It is recommended that parents continue to reconstitute infant formula with boiled tap water until the results of ongoing research are available.
- Many of the brands of bottled water available in Ireland are not suitable for use in the reconstitution of infant formula, due to the presence of salt and other substances which may be harmful to infants and young children.
- The use of ready-to-feed infant formula which is manufactured in non-fluoridated areas in the EU, for all or some of an infant's daily feeds, would reduce the amount of fluoride ingested. There is a negligible amount of fluoride in these preparations.

Fluoride Toothpaste

The inappropriate use of fluoride toothpaste during infancy and early childhood is associated with the development of dental fluorosis in permanent incisor teeth. This may be due to the use of fluoride toothpaste in children before age 2 years along with use of excessive amounts of fluoride toothpaste by older children (up to the age of 5 or 6 years), who may not have yet developed the ability to adequately rinse their mouths after brushing and may swallow most of the toothpaste. **A small, pea-sized amount of paste is all that is required** as shown in the photograph below..



The main chapter gives an account of the amount of fluoride on a body weight basis that a child may consume if he/she swallows a pea-sized amount of fluoride toothpaste each time the teeth are brushed. This amount of fluoride consumed on a regular basis can result in the development of dental fluorosis.

Control Strategies

- Fluoride toothpaste should not be used until approximately 2 years of age. Prior to this age parents can brush their children's teeth with a toothbrush and tap water. Professional advice on the use of fluoride toothpaste should be sought where a child below this age is considered to be at risk of developing dental decay.
- Children aged 2 to 7 years should be supervised when brushing their teeth to ensure that only a small pea-sized amount of fluoride toothpaste is used and that the paste is not swallowed. See photograph.
- Guidelines for dental care in childhood should be developed for use by all those involved in advising members of the public on health care matters.

Fluoride Supplements and Mouth Rinses

Fluoride supplements are a risk factor for fluorosis in young children when used inappropriately and not conforming to appropriate dosage schedules. However, the use and availability of fluoride supplements in Ireland does not appear to be an issue.

The inappropriate use of fluoride mouth rinses can cause fluorosis. However, as these rinses are not generally recommended for children less than 6 years of age, this should not be a contributory factor.

13 The Ethical and Legal Dimension

While the members of the Forum considered that a detailed treatment of ethical and legal considerations arising from the fluoridation of public drinking water supplies lay outside its remit, they were nonetheless concerned from the outset that such matters should be addressed in the Forum Report, even if only briefly. This position was reinforced considerably by the many submissions received in the public consultation exercise, in which such questions were raised. Accordingly, a Sub-Group was established to consider the ethical and legal dimension.

This is a field which is both wide and complex and thus does not lend itself to summarisation. The Forum heard two major presentations on these topics from a member expert in this area, and these were invaluable to those considering this topic. The Forum came to the view that rather than attempt to précis the presentations, and thereby run the risk of distortion occurring, they should be included in full as one of the Appendices to the Report.

The reader of this Executive Summary will therefore appreciate that it is even more impractical to treat these complex issues briefly here. However, as the Sub-Group consulted an expert in ethical matters and posed three key questions, it may be useful to quote both questions and answers received, with the proviso that to see the complete picture as it appeared to the Forum it is essential that reference be made to both Chapter 13 and Appendices 16 and 17 of the Report.

Question 1

Does the addition of fluoride to drinking water pose any particular ethical problem?

Answer

Even though fluoride is in piped water, there is still an element of choice. People can choose not to drink tap water. Admittedly the choice is not an easy one, and if the State were concerned about real choice, then consideration would have to be given to supplying an alternative source of water.

Question 2

What about the breaching of bodily integrity and interference with autonomy?

Answer

The addition of fluoride to the water supply is a paternalistic intervention by the State to safeguard the dental health of its citizens. Health in general is seen as an area where paternalistic State intervention is justifiable, and in terms of oral health, the poor dietary habits of the Irish people could be seen as a justification for taking a paternalistic approach. The State makes other interventions which could be seen to breach bodily (and mental integrity) in a much more serious manner, e.g. education. Therefore, the degree of infringement of bodily integrity by fluoridation is relatively minor.

However, if more weight were to be given to autonomy, then a programme of oral health education could be introduced in conjunction with fluoridation, until the education alone could take over.

Question 3

What about the area of uncertainty in science, where it can never be stated categorically that something is completely safe?

Answer

Then it comes down to risk versus benefit. Does the benefit outweigh the risk sufficiently to allow that risk to be tolerated? If the precautionary principle were always followed, then nothing would ever be done. From an ethical viewpoint, risk can be justified if the benefit significantly outweighs the risk.

The above is very much a capsule summary of extremely broad questions. However, the reader should note that the expert who replied to the key questions supplemented his replies with a valuable commentary, which is treated in Chapter 13 of the Report.

Finally, it may be remarked that while this is an area where considerations are often contradictory, and do not lend themselves to definitive statements, on balance, the net position is that the practice of fluoridation – when carried on in accordance with current practice in oral and general health – does not breach ethical or legislative principles.

14 The Programme of Oral Health Research in Ireland

This chapter outlines the programme of oral health research which has been undertaken in Ireland since the middle of the twentieth century. The oral health care industry has played a major role in this research, in particular in the development and promotion of products which have been effective in reducing the burden of dental disease worldwide. These activities have been undertaken in close collaboration with public health authorities, the two academic institutions involved in dental education and general dental practitioners.

The Department of Health and Children has commissioned a large research programme, which is being undertaken by the country's two dental schools on behalf of the health boards. This involves two national surveys, one of adults and one of children's oral health. The contract is divided into two lots:

Lot 1 involves an epidemiological survey of oral health in both adults and children, which is investigating the differences in oral/dental health between fluoridated and non-fluoridated communities.

Lot 2 involves research into all delivery methods of fluoride and will look at water fluoridation, fluoride toothpastes and mouth rinses and fluoride supplements. This lot is being undertaken in three parts: the first is a situation analysis, the second is concerned with total fluoride ingestion and absorption and the third will look at fluoride and bone health.

Another current topic of research is the use of oral health care products, including the extent to which these products contribute to the total consumption of fluoride. The Oral Health Research Centre in Cork is collaborating with laboratories around the world to develop a method of determining the fluoride content of foods and drinks.

