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# WATER FLUORIDATION

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In recent months the debate surrounding water fluoridation appears to have come back on to the political agenda. In June 1993, the Secretary of State for Health, Virginia Bottomley, told the annual conference of the National Association of Health Authorities and Trusts that she would be *"outraged"* if she did not have fluoride in her own water. Replying to a questioner who called for new laws requiring water companies to add fluoride, she said that *"what I think we must do is have urgent and rather forceful discussions with water companies and see if we cannot see a way forward"* [1].

Shortly after this, on 6 July 1993, the BBC2 television programme **Nature** broadcasted claims that fluoridation was linked with cancer and problems with the human immune system. In the programme, the Shadow Secretary for Health, David Blunkett, expressed concern about the principle of water fluoridation, stating that *"I don't believe we should put fluoride in the water supply as a mass medication because I don't think that gives us any choice"* [2].

This paper examines the current evidence surrounding the efficacy and safety of water fluoridation, the legal process by which fluoride can be added to water and discusses the arguments in favour and against fluoridation.

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## I. What is fluoride?

Fluoride is a word used to describe certain chemical compounds containing the chemical element fluorine. Fluoride compounds are widely found in nature, being more abundant than those of chlorine, zinc, copper and lead. One important source is the mineral fluor spar (fluorite,  $\text{CaF}_2$ ) containing about 49% fluorine and found widely throughout the world [3].

Traces of fluoride are found in most natural water, with sea water, for instance, containing about 0.3 milligrams per litre (mg/l). The recommended level of artificial fluoridation for drinking water, to help prevent dental caries (cavities), is 1 mg/l which is equivalent to one part per million (ppm). Similar levels of fluoride are naturally found in drinking water in some areas of Britain. Fluorides are also found in many foods, although typical concentrations are 0.2-0.3 ppm or less [4]. However, both tea and seafoods can have higher levels.

## Where does it come from?

As described above, fluoride chemicals occur naturally in the earth's crust and other fluoride compounds can be manufactured by a variety of different methods.

As far as the artificial fluoridation of drinking water is concerned, most companies in England and Wales use hexafluorosilicic acid,  $\text{H}_2\text{SiF}_6$ , also known as fluorosilicic acid or fluosilicic acid. Hexafluorosilicic acid (HFA) can be manufactured by a variety of means, but the largest source for the chemical is from the production of phosphoric acid which is used in the manufacture of fertilisers. The phosphoric acid is obtained by treating phosphate rock such as fluorapatite,  $\text{Ca}_{10}\text{F}_2(\text{PO}_4)_6$ , with sulphuric acid. This also yields fluorine containing compounds such as silicon tetrafluoride ( $\text{SiF}_4$ ) from which HFA can easily be obtained [3]:

*Fluosilicic acid is manufactured by scrubbing the gases from phosphate fertilizer plant operations containing various quantities of HF [hydrogen fluoride] and  $\text{SiF}_4$ ; in most instances much more  $\text{SiF}_4$  than HF is evolved, and, thus, the fluosilicic acid is formed by the reaction of  $\text{SiF}_4$  with water. Minor quantities are made by reacting silica with hydrofluoric acid.*

The source of HFA used in water fluoridation is of interest, because some anti-fluoridationists claim that the chemical is a waste product and has no other uses. In the UK, most of the water companies do favour HFA as the chemical to be used in fluoridation, and most of them obtain their supplies of the chemical from Hydro Chemicals Ltd based in Immingham in South Humberside. The company states that all of its supplies are imported from the continent, but that the exact process by which HFA is manufactured is commercially confidential [5]. They say that HFA is not a waste product but specifically produced from the production of phosphoric acid, and that the majority of HFA is used in the production of aluminium fluoride rather than for the fluoridation of drinking water.

## II. Statutory Basis for Fluoridation

Prior to 1985, there was no explicit statutory basis for water fluoridation in the UK although many water fluoridation schemes were in existence. This factor became of crucial importance when in 1978, Strathclyde Regional Council agreed to fluoridate its water supplies at the request of the local Health Boards, following a vote in which there was a majority of one. This decision was challenged by a Glasgow resident, Mrs Catherine McColl, who sought an interdict to prevent the council from going ahead with fluoridation [6,7]. The interdict was based on four main grounds [8 at p.1]:

- (1) *That fluoridation of the water supplies...would be ultra vires the respondents [ie. beyond the legal powers of the council - the respondents]*
- (2) *That it would be a nuisance inasmuch as fluoride being a known toxic substance may be harmful to consumers, particularly in relation to the causation and acceleration of cancer*
- (3) *That inasmuch as fluoride is a known toxic substance the addition thereof to the water would constitute breaches of the statute which imposes upon the respondents the duty to provide a supply of wholesome water for domestic purposes*
- (4) *That fluoridation of the water supply would be unlawful inasmuch the Respondents would be supplying a medicinal product for a medicinal purpose without a statutory product licence.*

The hearings began at the Court of Session, on 23 September 1980. The case ran until 26 July 1982, and, lasting for 201 sitting days, it was one of the longest and costliest in Scottish legal history [6]. The judge, Lord Jauncey, delivered his opinion on 29 June 1983, with the judgment running to some 400 pages [8]. In this, he found in favour of the first point, granting an interdict, but found against the other three points. His ruling on the point of *ultra vires* centred on the interpretation of the 1946 and 1980 Water Acts in relation to the supply of *wholesome* water [8 at p.384]:

*In my view the word "wholesome" falls properly to be constructed in the more restricted sense advocated by the petitioner as relating to water which was free from contamination and pleasant to drink. It follows that fluoridation which in no way facilitates nor is incidental to the supply of such water is out with the powers of the respondents. The petitioner therefore succeeds on this branch of her case.*

The Government did not make an immediate response to the judgment, but said that it would consider the implications. The then Secretary of State for Social Services, Norman Fowler, then announced the Government's response in December 1983 (**HC Deb**, 6 Dec 1983, c.142W):

*...Fluoridation has been supported by successive Governments as a safe and effective public health measure and we consider that Lord Jauncey's opinion amply demonstrates that the Government should continue to support fluoridation as a positive means to promote good dental health. It is therefore the Government's intention, when the parliamentary timetable permits, to bring forward legislation which will clarify the power of water authorities in Scotland to add fluoride to the water supply on the recommendation of the appropriate health boards. Lord Jauncey's judgment is not binding outside Scotland but for the avoidance of any doubt the Government propose that the legislation should also cover all statutory water undertakers in England and Wales and that corresponding legislation should be enacted for Northern Ireland. In the light of Lord Jauncey's confirmation of the safety and beneficial effect of fluoridation my right hon. Friend the Secretary of State for Wales and I have agreed to maintain the current indemnities in respect of fluoridation schemes in England and Wales until the legislation is enacted. In Northern Ireland indemnities are unnecessary as the water undertaker is a Government Department.*

The **Water (Fluoridation) Bill** was introduced by the Government in December 1984 (**HC Deb**, 20 Dec 1984, c. 574). The Bill sought to provide *specific powers for a statutory water undertaker to increase the fluoride content of the water supply to a particular area when requested to do so by the appropriate Health Authority or Health Board*. The original Bill was very simple, stating that water authorities *may* add fluoride to the water supply following an application from the local health authority. During its passage through both Houses of Parliament the Bill was amended in two significant ways. One new section was added which allowed existing fluoridation schemes to continue, and another section was introduced to require health authorities to publicise and consult on their applications to introduce new fluoridation schemes. The Bill received Royal Assent on 30 October 1985.

The provisions of the **Water (Fluoridation) Act 1985** did not extend to Northern Ireland, but in December 1986, the Northern Ireland Office published a proposal for a **Draft Water (Fluoridation) (Northern Ireland) Order 1986**. The order was debated in the House of Commons in July 1987 [9] and in the House of Lords in October 1987 [10] with the **Water (Fluoridation) (Northern Ireland) Order 1987** (SI 1987/2052, NI 21) being made on 26 November 1987 and coming into force on 27 January 1988.

In England and Wales the provisions of the Act have since been consolidated into sections 87-91 of the **Water Industry Act 1991**.

### **Procedures for Introducing New Fluoridation Schemes**

Under the appropriate legislation, as described above, water fluoridation can only go ahead once the local health authority has made a written application to the water undertaker. Prior to this application, the authority must have undergone a three month consultation period, first advertising its intentions in the local press. This consultation must involve the relevant local

authorities. Once the consultation period has ended, the health authority must consider the representations made to them and the opinion of the local authorities in deciding whether they should proceed with their application to add fluoride to the water supplies. The public have a right of admission to the health authority's final meeting to decide whether to proceed with a request for fluoridation. If the authority does decide to ask for fluoridation, the water undertaker may add fluoride to the water supply, but is not legally obliged to do so.

The Department of Environment has issued water undertakers guidance on how they should approach an application from a health authority for fluoridation [11]:

#### *THE ROLE OF WATER UNDERTAKERS*

*The Department expects water undertakers to be chiefly concerned with the technical feasibility rather than the principle of fluoridation which is a matter for health authorities to consider. To this end it would be helpful if undertakers made available to regional and district health authorities on request an assessment of the technical feasibility and estimated costs of fluoridation to assist health authorities in deciding whether to make formal applications for a scheme. In determining technical feasibility, undertakers will need to take fully into account any long term proposals or possibilities for transferring water from one area to another, and the statutory limitations on providing fluoridated water outside the area covered by the possible scheme (section 1(6) of the Water (Fluoridation) Act 1985). This may involve explaining to the health authorities which areas it would be feasible to fluoridate without the scheme being endangered by future water supply strategy.*

*The cost of fluoridation schemes is borne by the health authorities concerned, and all costs incurred by water undertakers on schemes should therefore be recompensed.*

*In the interests of simplicity the water undertaker should normally deal with the regional health authority on matters affecting a scheme which covers or may cover more than one district health authority area, as the regional authority will be acting as a co-ordinator for the district authorities. Where the regional authority does not take this role, one district will be nominated to take on co-ordination for all the authorities involved.*

Although this guidance suggests that water companies should be chiefly concerned with the technical feasibility of fluoridation rather the principle, some companies have rejected health authorities' requests for fluoridation on non-technical grounds [12]. For instance, North West Water has stated that it believes that there should be no additional fluoridation of water supplies unless there is substantial support for such a move from its customers [13]. Welsh Water has recently stopped its fluoridation schemes, and according to press reports this is only partly for operational reasons. A spokeswoman from the company has been quoted as saying that "*there is an overall feeling at the company that fluoridation is, essentially, adding a new chemical to drinking water that has nothing to do with quality*" [14].

This issue of whether a water undertaker should have the right to refuse a fluoridation request from a health authority was raised at various times whilst the Water (Fluoridation) Bill 1984/85 was passing through Parliament [15]. For instance, during the Second Reading debate, Sir John Page argued that water companies did not wish to be responsible for a decision to fluoridate (**HC Deb**, 14 Jan 1985, c.97):

**Sir John Page:** ...Representations were made to the Minister by the Water Companies Association, the president of which is our distinguished ex-colleague, Sir William Elliot, as well as the water authorities. I quote just one paragraph, which clearly summarises the worries of the industry. The Water Companies Association states:

"Our most serious concern arises over the fact that, as drawn, the Bill places the responsibility for the decision to fluoridate both on health authorities and water undertakers. In our view, this is quite wrong. Not only will this give rise to difficulties which always occur whenever responsibilities are 'split' but it is quite inappropriate that water companies should be required to involve themselves in a decision which is essentially political, medical and ethical. Water companies have no wish to involve themselves in these issues and certainly they are not medically competent to do so. The decision as to whether fluoridation is appropriate should be left entirely to health authorities" or, in the water authorities' view, to the Government as well as the health authorities.

"A water company should be required to comply with a request to fluoridate from a health authority subject only to the proviso that the water company could refuse to comply with such a request on the grounds of technical feasibility."

The Bill puts on water companies and water authorities a burden that they should not be asked to carry. It is the statutory duty of water undertakings to supply wholesome water. To add or not to add—that is a question that they should not be required to answer.

**Mr. Kenneth Clarke:** ...My hon. Friend's point is perfectly valid. The answer to it is that the Government took a conscious decision merely to seek to reinstate the existing policy and practice. Had we conceded the case of the water companies that they should have no discretionary power and that the responsibility should rest with the health authorities alone, the Government would have been attacked by a number of my hon. Friends for making fluoridation easier and removing an existing element of local discretion. The only reason why we have not been able in the Bill to meet the requests of the water undertakers is that we have been, if anything, over-scrupulous in meeting the concerns of my hon. Friends that we should not make it any easier than it is now to add fluoride to the water.

The decision of two local bodies will therefore be required - the health authority and the water authority - before fluoride can be added. It will then be up to the water authority to decide to what extent it wishes to be guided by the health authority.

### **Procedure Following a Decision to Fluoridate**

Once a water undertaker has decided to accept a health authority's request to fluoridate it must agree on the implementation of the scheme. Health authorities are responsible for all the costs of fluoridation, though 60% of capital costs are recoverable from central government. In addition, the Secretary of State for Health will provide water undertakers with indemnities against future legal damages awarded in respect of *adverse effects on a person's health caused by fluoridation*. Such indemnities are permitted under Section 90 of the **Water Industry Act 1991** (formerly s.172 of the **Water Act 1989**).

Guidance for health authorities and model agreements for implementing fluoridation schemes are provided in circulars from the Department of Health and the Scottish Office [16,17]. The Department of Health Circular ceased to be valid on 1 November 1992, but a new circular is expected early next year (1994).

Following agreement with the health authority, the water undertaker can proceed with the practical implementation of the fluoridation scheme. The Department of the Environment has published a Code of Practice on the **Technical Aspects of Fluoridation of Water Supplies** which *explains how fluoridation plants are to be established and operated in a safe manner* [18]. The Code contains detailed specifications of which chemicals and the type of equipment which can be used to add fluoride. All new plant must have *a continuous recording fluoride monitor, linked to an appropriate alarm system and automatic plant shut down*. Existing plants do not need such monitors if samples leaving the water works are analysed for fluoride concentration every four hours. Undertakers are expected to fluoridate water at the concentration of 1 mg/litre, and the alarm system is expected to be activated at concentrations less than 0.8 mg/litre and at concentrations greater than 1.2 mg/litre.

### III. Prevalence of Fluoridation in the UK

Currently, in the UK, large scale water fluoridation schemes only exist in England. Neither Scotland nor Wales have any fluoridation schemes, and Northern Ireland only has two very small schemes affecting less than 10,000 people.

It is difficult to be precise about the exact number of people receiving artificially fluoridated water in England as figures and information are not currently collected centrally by the Department of Health [19,20]. The Department is aware, however, of the water companies which have fluoridation schemes in operation [21]. In the absence of central information, there are two sources for the relevant figures: the water undertakers; and the district health authorities.

#### Water Undertaker Figures

According to the water companies, 4.7 million of their customers were receiving artificially fluoridated water in June 1993 [22]. Individual figures for the seven companies which supply such water are shown in Table 1 below. These data were obtained from the individual water companies in June/July 1993 and reflect the situation at that particular point in time. In many water company areas, the actual number of customers receiving artificially fluoridated water fluctuates as water treatment plants are taken out of service for repair or refurbishment, or are closed down. Additionally, new plants can be commissioned in accordance with existing or new fluoridation agreements with the health authorities.

<b>Water Undertaker</b>	<b>Number</b>
Severn Trent Water Ltd (incl. East Worcester Water)	1,585,000
South Staffordshire Water PLC	1,190,000
Anglian Water Services Ltd	770,000
North East Water PLC	721,000
North West Water Ltd	213,000
Northumbrian Water Ltd	180,000
Thames Water Utilities Ltd	57,000
<b>Total</b>	<b>4,716,000</b>

### Health Authority Figures

The last major study of the number of people receiving fluoridated water in England and Wales was conducted by the British Fluoridation Society in June 1988 [23]. The Society is a pro-fluoridation group and is partly funded by the Department of Health. Their study was conducted in the following manner:

*Each district dental officer in England and chief administrative dental officer in Wales was sent a brief questionnaire on which they were asked to provide details of the concentration of fluoride, both natural and artificial, in their district's water supply, the size of the population consuming water at each fluoride level, and the date of implementation of water fluoridation schemes.*

This survey found that a total of 5.9 million people were receiving artificially fluoridated water at a concentration of greater than 0.9 mg/litre. The breakdown of this figure into individual regional health authority areas is shown in Table 2 below:

<b>Table 2: Individuals receiving artificially fluoridated water at a concentration of 0.9 mg/l and over (1988)</b>	
<b>Regional Health Authority</b>	<b>Number</b>
West Midlands	3,574,226
Northern	972,852
Trent	707,686
NW Thames	265,572
Yorkshire	229,572
Wales	75,740
Mersey	59,605
Oxford	50,653
<b>Total</b>	<b>5,935,906</b>

Obviously the total figure of 5.9 million obtained in 1988 from the district dental officers is somewhat greater than the figure of 4.7 million obtained from the water companies in June 1993. Some of the difference can be explained by the fact that the 1988 figures are now out of date. For instance, there are no fluoridation schemes in Wales at present, and the current

agreements for the West Midlands RHA extend to 3.35 million people rather than the 3.57 million people in 1988 [24]. The remaining differences are partly explained by the fact that certain fluoridation schemes may be temporarily suspended due to work at water treatment plants. Currently, many treatment plants are being upgraded to take account of the EC drinking water directive (Directive 80/778/EEC). One other factor that may also be important is that more and more water companies are moving water about within their supply areas. Since they are only allowed to supply fluoridated water to those areas with which there are health authority agreements, some fluoridation schemes may have been terminated to allow companies to make full use of their water resources. The situation should become clearer when the British Fluoridation Society publishes the results of a more recent survey of the district health authorities early next year.

In addition to the individuals receiving artificially fluoridated water, substantial numbers also receive naturally fluoridated water. The figures for the number of individuals receiving fluoridated water, either natural or artificial, at different fluoride concentrations are shown in Table 3 below, for England and Wales. These figures are obtained from the 1988 British Fluoridation Society survey so, they may also now be out of date.

<b>Table 3: Total number of individuals receiving fluoridated water at an appreciable concentration (1988)</b>			
<b>Type of fluoride</b>	<b>Fluoride Concentration</b>		
	0.3-0.7 mg/l	0.7 -0.9 mg/l	Over 0.9 mg/l
Natural	2,698,523	388,410	177,176
Artificial	-	89,605	5,935,906
<b>Total</b>	2,698,523	478,015	6,113,082

Although figures for the size of populations receiving fluoride are not collected centrally, the Department of the Environment does publish a map of the fluoride concentration in water supplies throughout England and Wales in its annual **Digest of Environmental Protection and Water Statistics** [25].

Future prospects for water fluoridation schemes in the different parts of the UK are discussed in the final section of this paper.

#### IV. Scientific and Medical Evidence Concerning Fluoridation

In recent years, there have been many different studies and reviews of the health effects of fluoride. All the major reviews on fluoridation conducted by established organisations have concluded that water fluoridation is beneficial and safe, though some individual research papers in recent years have suggested that there are adverse health effects associated with water fluoridation. Examining the validity of the claims put forward in such papers can be difficult, especially as the debate over fluoridation can at times be particularly partisan and controversial.

Those who oppose fluoridation on health grounds tend to do so because of three main concerns. They believe that fluoride is a poison, that it causes cancer and that it is linked to hip fractures:

##### **Fluoride as a Poison**

There is no doubt that at high doses fluoride is poisonous. Chronic fluorine poisoning is known as "fluorosis" and causes a sclerosis (or hardening) of the bones and calcification of ligaments. It is estimated that the human lethal dose is between 2.5 to 5.9 grams of fluoride, with large doses causing very severe nausea, vomiting, diarrhoea, abdominal burning and cramp-like pains [26]. However, many other chemicals found in drinking water are also toxic at high levels (eg. iron and lead). When considering the toxicity of any chemical in drinking water it is established scientific practice not to assume that a particular effect caused at a high dose of fluoride will occur in a milder form at low doses. So, for instance, in trying to use the results of animal studies as a guide to the effects of fluoride on humans careful consideration must be made of the dose levels and concentration of fluoride used.

The World Health Organisation (WHO) has recently published its revised **Guidelines for drinking-water quality** [27]. A "guideline value" represents the concentration of a chemical in drinking water that "*does not result in any significant risk to the health of the consumer over a lifetime of consumption*". The guideline value for fluoride has remained unchanged from the previous edition of the Guidelines and is set at 1.5 mg/l. An identical maximum level is specified in the UK drinking water regulations [28]. The WHO Guidelines state that:

*There is no evidence to suggest that the guideline value of 1.5 mg/litre set in 1984 needs to be revised. Concentrations above this value carry an increasing risk of dental fluorosis, and much higher concentrations lead to skeletal fluorosis. The value is higher than that recommended for artificial fluoridation of water supplies [1 mg/l].*

##### **Fluoride as a Cause of Cancer**

Some of the most controversial claims about water fluoridation is that it causes cancer. Such claims have been put forward in particular by an American biochemist, Dr Yiamouyiannis,

and by Dr Dean Burk, formerly of the US National Cancer Institute. Both of them acted as witnesses for the petitioner in the McColl case [8], and Yiamouyiannis figured heavily in the BBC *Nature* programme on fluoridation [2].

The claim that fluoride has a role in the *causation and acceleration of cancer* was raised directly in the McColl case. In his judgment, Lord Jauncey commented that [8 at p.231]:

*In summary fluoride at a concentration of 1 p.p.m. is not mutagenic [it does not cause genes to mutate], the biochemical evidence discloses no mechanism whereby it is likely to cause cancer and the epidemiological evidence discloses no association between the fluoridation of water supplies and an increased C.D.R. [Cancer Death Rate].*

The issue of fluoridation and cancer was also examined in depth by a working party set up in 1980 by the then Minister for Health, Gerard Vaughan, following the publication of a number of studies purporting to show a statistical link between the two, particularly those of Yiamouyiannis and Burk. The working party published its report, known as the Knox Report in January 1985 [29]. The main conclusions of the report were:

*We have found nothing in any of the major classes of epidemiological evidence which could lead us to conclude that either fluoride occurring naturally in water, or fluoride added to water supplies, is capable of inducing cancer, or of increasing the mortality from cancer. This statement applies both to cancer as a whole, and to cancer at a large number of specific sites. In this we concur with the great majority of scientific investigators and commentators in this field. The only contrary conclusions are in our view attributable to errors in data, errors in analytical technique, and errors in scientific logic.*

*The evidence permits us to comment positively on the safety of fluoridated water in this respect. The absence of demonstrable effects on cancer rates in the face of long-term exposures to naturally elevated levels of fluoride in water: the absence of any demonstrable effect on cancer rates following the artificial fluoridation of water supplies: the large human populations observed: the consistency of the findings from many different sources of data in many different countries: lead us to conclude that in this respect the fluoridation of drinking water is safe.*

*The routine monitoring of public health has been an important feature of many fluoridation programmes, and has contributed to the confidence with which we can assert the safety of fluoridation with respect to cancer. We recommend that such monitoring should continue.*

The WHO drinking water guidelines, as mentioned above, state that in 1987 the International Agency for Research on Cancer (IARC), classified fluorides as belonging to *Group 3*, that

is *the agent is not classifiable as to its carcinogenicity to humans*. The Guidelines comment that *although there was equivocal evidence of carcinogenicity in one study in male rats, extensive epidemiological studies have shown no evidence of carcinogenicity in humans*.

More recently, in April 1993, Yiamouyiannis published a paper claiming that there is a link between bone and oral cancer and fluoridation [30]. He concludes in the paper that:

1. *The preponderance of evidence shows that fluoridation is causing an increase in bone cancer and deaths from bone cancer in human populations among males under age 20.*
2. *The increase in bone cancer attributable to fluoridation may all be due to an increase in osteosarcoma [bone cancer] caused by fluoride*
3. *The preponderance of evidence shows that fluoridation is causing an increase in oral cancer among human populations*
4. *Since fluoride has been linked to bone and oral cancers in animals and humans, its biochemistry and its ability to inhibit the DNA repair enzyme system, to accelerate tumor growth rate, to inhibit the immune system, to cause genetic damage in a number of different cell lines, and to induce melanotic tumors and cancers, strongly indicate that fluoride would have a generalized effect on increasing cancers overall.*
5. *According to our estimates, over 10,000 cancer deaths are caused each year in the United States by fluoridation; this supports the conclusion that fluoridation is causing other types of cancers in humans.*

These claims are likely to be treated with some caution by medical researchers, both because of the judgements which have been made of Yiamouyiannis' previous work and because the paper was not published in an established medical journal. In fact, the paper has been criticised by Sir Richard Doll, the eminent epidemiologist, and others in a letter published in the **British Medical Journal** in August 1993 [31]. In their letter they state that:

*The article in which Dr Yiamouyiannis sets out his views misrepresents work reported by others. In fact, extensive analyses carried out by the National Cancer Institute in the United States have shown no evidence of any general increase that could be attributed to fluoridation, and detailed analyses relating specifically to osteosarcomas have led to the same conclusion. Data on temporal trends in the risk of bone and joint cancer have shown no increase associated with fluoridation in Canada, Europe, Australia or New Zealand. Geographical comparisons between fluoridated and unfluoridated areas have shown no difference in the incidence of osteosarcoma or bone cancer in males aged 10-19 in the fluoridated areas of New Jersey, and a lower rate in the west midlands of England.*

### Fluoride as a Cause of Hip Fractures

Reports from the USA and from the UK have indicated that there is a statistical link between fluoride levels in water and the incidence of hip fracture [32]. The studies have analysed the rates of hip fractures in different areas and compared them with the concentration of fluoride in drinking water in those areas. They found that as the concentration of fluoride in areas increases, so does the rate of hip fractures (on average). However, the authors of the study made in England state that:

*...The relationship observed may be spurious due to the confounding of some other factor that has not been accounted for in our analysis. Furthermore, an adverse impact of such low levels of fluoride appears biologically implausible, despite the recent trials suggesting such a consequence at much higher doses than in our study. Nevertheless, this positive association demands further investigation at the individual level.*

One of the authors of the report has stated that he does not believe that the study showed that fluoridation caused hip fractures [33]. He commented that the study centred on different areas, some with fluoridation and some without, and it could be that the higher incidence of hip fractures should be attributed to some other geographical factor not taken into account in the study.

### Recent Reviews of the Health Effects of Water Fluoridation

The most recent review of water fluoridation was published by the United States National Research Council in August 1993 [34]. An article in the **New Scientist**, 28 August 1993, summarised the review as follows: [35]:

*Fluoride added to America's drinking water to prevent tooth decay is not likely to cause bone disease or other maladies linked to high doses of the element, says the National Research Council in a report published last week.*

*The agency concludes that the federal government's limits on the amount of fluoride in drinking water are enough to protect the public from harmful effects, such as cancer, kidney disease, infertility and genetic defects.*

*The US Environmental Protection Agency limits fluoride to 4 parts per million in drinking water, which it says is enough to reduce tooth decay without causing damage. But critics claim that even trace amounts of fluoride could weaken bones.*

*The National Research Council ratified the EPA's standard, concluding the fluoride's harmful effects have surfaced only in studies in which it has been used in higher concentrations than the EPA allows.*

*The US Centers for Disease Control and Prevention estimates that 132 million Americans - or about 62 per cent of the population - are served by water systems with at least 0.7 parts per million of fluoride, the minimum level thought to prevent cavities.*

A comprehensive study on the benefits and risks of water fluoridation was published by the United States Public Health Service in 1991 [36]. This report found that animal studies failed to establish an association between fluoride and cancer and that there was no credible evidence of any association between the risks of cancer and the exposure to either natural or adjusted fluoride in water. The report also concluded that there was a lack of evidence of associations between levels of fluoride in water and birth defects or problems of the gastrointestinal, genito-urinary, and respiratory systems. The report made several recommendations for future research both on the benefits of fluoride and the risks of fluoride.

A comprehensive account of the medical case against fluoridation was published in an article in the periodical **What Doctors Don't Tell You** in December 1992 [37]. This reports on studies that fluoride is ineffective in reducing tooth decay, that fluoride is linked to cancer and that fluoride can damage the immune system. An account of the case against fluoridation can also be found in a recent book by Yiamouyiannis, **Fluoride: The Aging Factor** [38].

### **Effectiveness of Fluoride in Treating Dental Caries**

Initial studies of the effects of fluoridation on the incidence of tooth decay or dental caries conducted in the 1940s showed reductions in the number of decayed, missing and filled teeth (DMFT) of about 60% [36]. However, more recent studies conducted in the 1980s show that the differences in caries scores between fluoridated and non-fluoridated areas have declined to 20-40% [36].

A review of all the research conducted into the efficacy of fluoride in reducing dental caries was published earlier this year by Professor Murray of the Department of Child Dental Health at the University of Newcastle [39]. This review looked at the data from 113 studies conducted in 23 countries and found that the modal (most common) reduction in DMFT values for all the studies was 40-49% for primary teeth and 50-59% for permanent teeth (24 out of the 66 studies on primary teeth and 33 out of 86 studies on permanent teeth were in these ranges).

The paper also presented figures for the dental health of 15-year-old children who had lived all their lives in Hartlepool, Newcastle and Middlesborough where the concentrations of fluoride were 1.0-1.3ppm, 1.0 ppm and 0.2ppm respectively. The results of the study are shown in Table 4 below.

<b>Table 4: Dental Health of 15-year-old children in North East England</b>			
Place	Hartlepool	Newcastle	Middlesborough
Fluoride concentration	Natural 1.0-1.3ppm	Artificial 1.0ppm	Natural 0.2ppm
Number in group	254	227	259
<b>Mean D<sub>ecayed</sub>M<sub>issing</sub>F<sub>illed</sub>T<sub>eeth</sub></b>	1.7	2.5	3.3
<b>Caries free, %</b>	40	30	24

This table shows that the children living in Middlesborough with the lowest level of fluoride have the highest number of decayed, missing or filled teeth (DMFT) and are the least likely to be caries free. The study also found that children had to be continuously resident in the fluoridated areas to obtain maximum benefit in reducing tooth decay.

Some anti-fluoridationists argue that data showing fluoride reduces tooth decay is unreliable. In particular, John Colquhoun, New Zealand's former chief dental officer has argued that fluoridation actually increases the incidence of tooth decay. In 1984 he claimed that *when any unfluoridated area is compared with a fluoridated area of similar income level, the percentage of children who are free of dental decay is consistently higher in the unfluoridated area* [37].

However, the British Dental Association, the Royal College of Physicians, the World Health Authority (WHO) and other bodies all support fluoridation as an effective means of reducing dental caries.

### **Dental Fluorosis**

Another issue that is important in relation to dental health, is dental fluorosis. This issue was particularly highlighted in the **Nature** programme. The Oxford Reference **Concise Medical Dictionary** contains the following definition:

*Dental fluorosis is characterized by mottled enamel, which is opaque and may be stained. Its incidence increases when the level of fluoride in the water supply is above 2 parts per million. The mottled enamel is resistant to dental caries.*

There is considerable disagreement between those in favour of fluoridation and those against fluoridation about the level at which fluoride causes dental fluorosis and mottling of the teeth. Lord Jauncey commented in his judgment in the McColl case that fluoridation at 1ppm *would be likely to produce a very small increase in the prevalence of dental mottling which would*

*only be noticeable at very close quarters and would be very unlikely to create any aesthetic problems [8 at p.354].*

However, there can be a problem with dental fluorosis in children drinking fluoridated water if they swallow fluoride toothpaste whilst brushing their teeth. If significant amounts of toothpaste are ingested, then together with other sources of fluoride from food and water, they can receive more than the optimal amount of fluoride. The 1991 US Public Health Service Report made several recommendations in this area [36]:

*The PHS should sponsor scientific conferences to assess both the optimal level of total fluoride exposure from all sources combined and the appropriate usage of fluoride-containing dental products in order to achieve the benefits of reduced dental caries and to minimize the risks of dental fluorosis.*

*In accordance with prudent health practice of limiting exposure to no more than necessary to achieve a desired effect, health professionals and the public should avoid excessive and inappropriate exposure to fluoride (e.g., health professionals should prescribe fluoride dietary supplements only when the fluoride level of home water supply is known to be deficient. Parents should educate young children to minimize swallowing of fluoridated toothpaste and to use only small amounts of toothpaste on the brush).*

*The FDA [Food and Drug Administration] should review the labelling required for toothpaste and other fluoride-containing products to ensure that information is sufficient to enable the public to make informed decisions about their use, especially for young children (i.e., those < [less than] 6 years of age).*

*Manufacturers of toothpaste should be encouraged to clearly communicate the fluoride levels in their products. Manufacturers should determine whether toothpaste can be dispensed in a dose-limited container for use by children. Manufacturers of dental products should determine whether the levels of fluoride can be reduced while preserving clinical effectiveness.*

The issue of water fluoridation and the use of fluoridated toothpaste was raised in a PQ by Sir Ivan Lawrence in February 1991 (**HC Deb**, 14 Feb 1991, c.555W). The then Parliamentary Under-Secretary at the Department of Health, Steven Dorrell, replied:

*The total daily oral intake of fluoride from food, water and fluoridated toothpaste in those areas in the United Kingdom where the drinking water contains fluoride at 1 part per million, whether present naturally or added, is too low to have any adverse effect on health.*

*A study to compare the effect on enamel formation of the use of fluoride toothpaste in fluoridated Birmingham and non-fluoridated Leeds concluded that while there was a higher level of mild fluorosis in the fluoridated area there was no evidence of an increase in the higher grades of fluorosis, and that the use of fluoride toothpaste by*

*young children in fluoridated areas was unlikely to produce aesthetically unacceptable levels of enamel fluorosis.*

*Not all toothpastes are licensed medicinal products. The EC cosmetic directive permits the addition of fluoride ion up to 1,500 ppm. No toothpaste on the United Kingdom market contains more than this and most are limited to 1,000 ppm. A voluntary agreement has been reached with the Cosmetics, Toiletries and Perfumeries Association to include information on packaging about the amount of toothpaste to be used when cleaning teeth. A toothpaste containing more than 1,500 ppm would only be available on prescription.*

## V. The Right to Choose and Other Arguments

In addition to the health related arguments over fluoridation, those opposed to fluoridation present two other arguments: firstly, that every individual should have the choice as to whether or not they ingest fluoride, and that right cannot be exercised if water is fluoridated; and that secondly, fluoridation is mass-medication and as such it is wrong.

### The Right to Choose

Those in favour of fluoridation argue that *those who object to it are in the position of depriving the community of a benefit at no cost to themselves, save that of having their personal preference frustrated*. They argue that *the right to fluoride free water supply is not a basic civil right and it is not a right of importance comparable to free speech, freedom of assembly, or equal protection before the law* [40].

However, those opposed to fluoride would argue against this, and say that if people wish to receive fluoride then they could take dietary supplements to increase their fluoride intake.

An important issue in connection with the right to choose is the attitude of the general population to water fluoridation. The British Fluoridation Society, the lobby group in favour of fluoridation, have stated that [41]:

*Public support for fluoridation is now the highest ever recorded, according to the latest nationwide opinion survey.*

*This shows that 79% of people think fluoride should be added to water if it can reduce tooth decay.*

*The survey conducted by NOP in May 1992, is based on just over 1,100 interviews with a randomly selected sample of people across England, Scotland and Wales.*

*Support was high among all sections of the population reaching 89% among those aged 16 to 24 years.*

*Previous nationwide opinion surveys carried out between 1980 and 1987 showed public support gradually rising from 66% to 76%.*

*The latest survey has found that support is continuing to rise.*

Those opposed to the fluoridation might question the validity of such polls and assert that the question "*Do you think fluoride should be added to water if it can reduce tooth decay?*" will produce a biased response.

The question of public support for fluoridation and opinion polls was raised in a letter to the **British Medical Journal** from workers at the Dumfries and Galloway Health Board in

April 1993 [42]:

*...Last November Dumfries and Galloway Health Board carried out a survey of the attitudes to fluoridation of the public in its catchment population. A 5% random sample of the local population aged 18 and over (n=5916) was sent a postal questionnaire which generated a response rate of only 41.4% (n=2449). Although most of the respondents (1422) were in favour of fluoridation, a considerable proportion (996) were opposed to such action. Of particular concern, 423 respondents strongly disagreed with such action. Furthermore, 148 respondents wrote detailed unsolicited comments, which with few exceptions were opposed to fluoridation. By contrast 58.6% of the population chose not to respond. We conclude that a simple poll may not give sufficient insight into the variety and strength of public feeling on such issues.*

*These results also beg the question whether a small majority in favour of a public health measure gives a health authority the mandate to overrule the strongly held views of a sizeable minority*

The statistical results of such a poll where people are invited to respond to a questionnaire should be treated with caution, as they are not as scientifically rigorous as formal opinion polls. Nevertheless, this type of survey can still provide some interesting information on the views of the general public.

### **Mass Medication**

Those opposed to fluoride argue that fluoridation is wrong because it is a form of mass medication. Speaking on the BBC **Nature** programme, David Blunkett, the Shadow Secretary for Health commented that [2]:

*Fluoride can have an impact on peoples' well being, and even if fluoride is good for us as opposed to being harmful for us, and even as I think most people would accept that it does help prevent tooth decay in children, I don't believe we should put fluoride in the water supply as mass medication because I don't think that gives us any choice and I think it's a very dangerous principle. We could put vitamin C in the water supply because professionals tell us its good for us but that wouldn't make it right.*

The Department of Health has argued, however, that water fluoridation is not a form of mass medication. In a press statement issued to the **Nature** programme, the Department stated [43]:

*It is sometimes argued that adding fluoride to water with the intention of reducing tooth decay is a form of "medication". However, fluoride is naturally present at*

*varying levels in water supplies. Water fluoridation merely adjusts the level of fluoride to the optimum for dental health. Over half a million people in England drink naturally fluoridated water. Obviously these people are not being subjected to medication and this could also be said when the optimal concentration is artificially replicated.*

## VI. The Future

The Secretary of State for Health, Virginia Bottomley, recently outlined her views on fluoridation at the Water Companies Association annual luncheon on 7 July 1993 [43].

*Dental health is an area in which water companies can make an important contribution through fluoridating drinking water supplies at the requests of health authorities. North East Water and one of its predecessor companies have provided fluoridated water in the Newcastle area for almost twenty five years. Newcastle five year olds have 60% less decay than a comparable group in a non-fluoridated group in North Manchester.*

*We need to establish a greater degree of cooperation between water suppliers and health authorities in introducing fluoridation as a safe, effective and valuable health measure.*

The BBC **Nature** programme on water fluoridation suggested that the Department of Health has plans to extend fluoridation to 75 per cent of the UK population by the end of the decade. In response to a written question from the **Nature** team as to whether this was true, the Department of Health stated that [44]:

*The Water Industry Act 1991 gives water undertakers the power to fluoridate water supplies at the request of health authorities. Health authorities must undertake widespread statutory consultation before making such a request. This permits local decision-making on the matter. The final decision on whether to accede to a request for fluoridation rests with water undertakers who have been known to refuse health authorities' legitimate requests. We want to discuss with the water undertakers the reasons why health authorities requests are being turned down, thus frustrating this desirable, safe and cost effective health measure.*

Two meetings, one at official level and one at ministerial level, have recently taken place between the Department of Health and the Water Services Association, which represents the water and sewerage companies. However, it would seem that both meetings merely provided an opportunity for an exchange of views on the issue. The Department of Health does not, at present, have any plans to recommend a change in the law in this area to force water companies to undertake fluoridation at the request of a health authority [45].

Although there are no plans for changes in legislation at present, the number of fluoridation schemes could still increase in future under the current arrangements. The likelihood of this happening in the different parts of the UK is discussed in the appropriate sections below.

## England

North West Water is, so far, the only water and sewerage company in England to have publicly stated that it is opposed to an extension of fluoridation schemes within its area (see Section II, page 4). Some other companies would have great difficulty in extending water fluoridation on technical grounds because they move large quantities of water about within their area. For instance, Thames Water has recently finished construction of a huge ring main for supplying London's water and they could only supply fluoridated water if all the health authorities whose areas were supplied from the ring main had requested fluoridation.

However, currently, there are a number of water companies which have yet to make a decision about fluoridation and which have health authorities in their areas who are in the process of submitting formal applications for new fluoridation schemes. For instance, all the district health authorities within the area of Yorkshire Water have recently consulted on new fluoridation schemes and have unanimously decided in favour of the schemes. There has been a preliminary meeting between the health authorities and the company, but the authorities have yet to submit a formal application for fluoridation.

The Northern Regional Health Authority has recently announced that it wants to extend fluoridation to another 1.7 million people. According to a recent report in the **Northern Echo**, the *ten district health authorities are being asked to agree the plan as are the water companies whose supplies would be affected by the seven proposed schemes* [46]. The report stated that public consultations on the issue were due to start on 1 December 1993.

## Wales

Welsh Water currently has no water fluoridation schemes in operation, having stopped the two schemes in Anglesey which had run for 30 years during 1991. The company has expressed concern about the safety of fluoridation plant and the Chairman has said that the company would not continue fluoridation on Anglesey or extend fluoridation to the rest of Wales unless required to do so by the Secretary of State [12]. At the moment, under the existing legislation, the Secretary of State does not have the power to make such a request.

## Scotland

The situation in Scotland is slightly different from that prevailing in England and Wales in that water supply is a local authority function. The importance of this is that the decision as to whether or not a water undertaker, the local authority, agrees to a request for fluoridation is subject to a vote by the local authority councillors. A full meeting of Strathclyde Regional Council voted against fluoridation in July 1993 [47], and at the beginning of December the water and sewerage committee of Highland Regional Council also voted against fluoridation [48]. In November, Grampian Health Board stopped short of making a formal application following opposition from the public [49].

In September 1993, the Chief Medical Officer at the Scottish Office published his annual report for 1992. Commenting on the report, he stated that [50]:

*The dental health of Scottish school children has long been considerably worse than in most other comparable countries but was improving steadily in the 1980s. That improvement now appears to have ceased. The examination of 5 year old children conducted under the Health Boards' Dental Epidemiological Programme in 1991-92 revealed a slightly higher average number of decayed or filled deciduous teeth than the previous surveys in 1987 and 1989. This implies that, without fluoridation of the public water supply, there is little hope of achieving the Government's target that 60 per cent of five year old school entrants should have no cavities, fillings or extractions by the year 2000.*

With many local authorities opposed to water fluoridation, it is difficult to see how such fluoridation could be introduced on a wide scale across Scotland.

In the longer term, the situation in Scotland could change if the water and sewerage functions of local authorities are transferred to three new water authorities from April 1996 as proposed in the **Local Government etc. (Scotland) Bill** (Bill 6 1993/94). Background information on this reorganisation can be found in Library Research Paper 93/75, **Local Government Reorganisation in Scotland**. Board Members of the new water authorities will be appointed by the Secretary of State. It remains to be seen whether the new structures will produce a change in the way in which applications for new water fluoridation schemes from health boards are dealt with. In July 1993, Mr Jimmy Hood asked in a written PQ whether the Secretary of State would make it his policy that *fluoridation of drinking water should require the consent of the elected representatives of the population concerned* (**HC Deb**, 23 July 1993, c.501W). The Parliamentary Under-Secretary of State at the Scottish Office, Allan Stewart, replied:

*Under the Water (Fluoridation) Act 1985, water authorities may increase the fluoride content of public water supplies on the application of health boards. As regards the future composition of water authorities, my right hon. Friend has nothing to add to paragraphs 3.21 to 3.24 of the White Paper "The Structure of Local Government" published earlier this month.*

### **Northern Ireland**

In Northern Ireland, the situation is unlike that in the rest of the United Kingdom, as water supply is a function of the Department of the Environment. Currently, less than 10,000 people receive fluoridated water in Northern Ireland as there are only two very small schemes in operation. However, the four Health and Social Services Boards in Northern Ireland have developed plans for 21 new schemes which if implemented would result in 65-75% of the population receiving fluoridated water [51,52]. The Boards have already publicly consulted

and submitted a formal application to the Department of the Environment for four schemes. Two of these schemes are very large, covering 50% of the total population of Northern Ireland, one is at Dunore Point and the other is at Silent Valley. The two smaller schemes would cover about 100,000 people and are based at Carmoney and Caugh Hill. Although, approval for the schemes has yet to be granted, given that it is Government policy to support fluoridation, the Health Boards have no reason to suppose that their request will be turned down. Applications for the other 17 schemes will gradually be submitted over the coming years. The health boards hope that following the implementation of the first four schemes, which is expected to take two years, the remaining schemes will be in place ten years later.

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