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# The Water Fluoridation Debate

**Abstract:** Water fluoridation schemes have been employed for over 50 years. Water fluoridation has been a source of continuous debate between those who advocate its use as a public health measure and those who oppose it. There have been no new fluoridation schemes in the UK for nearly 30 years owing to principally legislative, but also geographic, financial, and political reasons. However, in early 2008, the UK Secretary of State for Health promoted the use of water fluoridation schemes for areas in England with the highest rates of decay. This article, the third and final article of three, aims to discuss the arguments surrounding water fluoridation and its continued relevance as a public health measure.

**Clinical Relevance:** This article aims to provide an update for general practitioners for the background and the current status of the water fluoridation debate and to enable them to answer non-clinical questions raised by patients.

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The first two articles in this series reviewed the history of fluorides in dentistry and of water fluoridation and the background for the evidence base that resulted in water fluoridation schemes. In this final article, we will examine the legal history and the current legislative status. We will discuss the arguments and evidence for those who advocate water fluoridation and those who oppose it as a dental public health measure. We will expand on the issues surrounding risk benefit for water fluoridation beyond dental fluorosis, and how they have altered with time. We will also discuss the continued relevance of water fluoridation as a contemporary public health measure.

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## Legal history and the new legislation

Legislation of the water industry in the UK to protect the public and regulate the safety of water supplies has been in place for over 100 years. It appeared as a response to an outbreak of cholera from a public water supply.<sup>1</sup> The majority of water companies were in the public sector for many years and were controlled at a governmental or local authority level. It was during this period of public ownership that the fluoridation schemes in the UK were introduced. On the basis that it was in the public's best interest, the water companies, both private and state owned, were persuaded to fluoridate water supplies. The companies were to fluoridate the water supply under a non-profit agreement whereby all appropriate costs were met by the state. However, a series of events in the 1980s changed the picture of water fluoridation with far reaching effects. The first of these events was a ruling given on a case before the Scottish judiciary.

Events began in 1978 when Strathclyde Regional Council, as the statutory water authority for the area, agreed to co-operate with the local Health Boards in order to fluoridate the water supply. In 1979, an elderly citizen of Glasgow, Mrs Catherine McColl, applied for

an interdict to restrain Strathclyde Council from implementing water fluoridation. This was granted pending court hearings. Mrs McColl's grounds for complaint were that water fluoridation was:

- *Ultra vires* meaning beyond the power of. In this case, that the implementation of water fluoridation was beyond the legal powers of Strathclyde Council;
- A nuisance, as fluoride was a known toxic substance harmful to consumers of fluoridated water;
- An infringement of the duty of the water authority to provide consumers with wholesome water for domestic purposes; and
- An infringement of the Medicines Act, 1968 as, by implementing water fluoridation (without a product licence) Strathclyde Council would be supplying a medicinal product for a medicinal purpose.

The plaintiff was granted legal aid and Lord Jauncey was appointed as the judge. As the first and last grounds for complaint were matters of law, no evidence was heard on these points. However, the other two points required the presentation of evidence. The hearings began on the 23rd September 1980 in the Court of Session, Edinburgh. What followed made the case famous not only for its subject matter, but for the cost and the length of the proceedings - it ran until 26th July 1982

(the Court having sat for a staggering 201 days – the longest case in Scottish legal history). Lord Jauncey took almost another year to consider the 21,000 pages of written evidence that had been amassed. When a verdict was finally reached on the 23rd June 1983, the judge sustained the Petitioner's plea in law that fluoridation, for the purpose of reducing the incidence of dental caries, was *ultra vires* the respondent, and the interdict was granted on this point and on this point alone. All her other pleas were rejected.

The outcome of the case was viewed as a moral victory for the anti-fluoridation lobby, despite the fact that all pleas pertaining to the efficacy and safety of water fluoridation were lost. Lord Jauncey stated that an '...individual's right to choose how to care for his own body should only be encroached upon by statutory provisions in clear and unambiguous language.'<sup>2</sup> This should have been interpreted as a legal, not moral judgement. However, the message was that the law needed to be clarified where there was an intention for the addition of fluorides to drinking water.

The ramifications of this ruling meant that existing fluoridation schemes, at least under the view of Scottish law, were unlawful. The Conservative government at the time were keen to pursue the option of water fluoridation as a cost-effective means of addressing dental caries. The *1985 Water (Fluoridation) Bill*<sup>3</sup> was seen as an attempt to address the legal shortcomings highlighted in Lord Jauncey's verdict. The Bill was seen to be a mechanism for the introduction of new water fluoridation schemes and set out clear roles and responsibilities for health authorities, water companies and the Secretary of State. However, there was another significant change in circumstance for water companies that occurred at this time - the privatization of water companies. In order not to jeopardize the privatization programme, a decision was taken to retain the right of the water companies to veto new water fluoridation schemes, a veto that was less significant when the water companies were in the public sector. This was seen as a solution whereby the newly formed private companies would not have restrictions placed on their operating practices by the public sector.

When the Act<sup>3</sup> was passed, the Government could be seen as being

supportive of the extension of water fluoridation schemes, whilst having made what could be interpreted as a conscious decision not to make the process easier. The Act included the section:

*If requested to do so by a relevant authority, a water undertaker **may** enter into arrangements with the relevant authority to increase the fluoride content of the water supplied by that undertaker to premises specified in the arrangements.*

Unsurprisingly, as a result of this change in legislation and the wording that provided water companies a veto, there were no new fluoridation schemes implemented. As an aside, it must be stressed that, even prior to these events, there were still overwhelming obstacles to overcome when it came to water fluoridation. The *NHS Reorganisation Act of 1973*<sup>4</sup> resulted in massive changes within the NHS. The NHS now encompassed the running of hospitals and community and preventive services, which included the transfer of the responsibility for water fluoridation from local government. Plans for water fluoridation were easily pigeon-holed when the broader picture of healthcare provision was considered. Added to this was increasing geographical and political pressure from within water companies, local government and even some Area Health Authorities.<sup>5</sup> The struggle for the West Midlands to extend the existing fluoridation scheme in the late 1970s and early 1980s is documented by Paul Castle in *The Politics of Fluoridation*.<sup>5</sup>

The first true test of the revised legislation of the *Water (Fluoridation) Act, 1985* and the *Water Industry Act, 1991*<sup>6</sup> that followed came about by a judicial review raised by Newcastle and North Tyneside Health Authority in 1998 following a refusal to a request from the Health Authority to Northumbrian Water to extend an existing water fluoridation scheme. The judicial review aimed to clarify the responsibility of the water company in the decision-making process. The Health Authority contested that Northumbrian Water had acted unlawfully by refusing their request and that the reasoning provided was illogical. The water company countered that they had the absolute right to veto such decisions and that, post privatization, they had a

right to protect shareholders and, under the current law, no other considerations (even public health) could take precedence. The presiding judge, Mr Justice Collins concluded that, as regrettable as it was, the water company had the absolute right under the existing legislation to refuse such a reasonable request.

As a consequence of the legislation failing to deliver what had been intended, a White Paper was commissioned in 1998 on public health. This included details that described the *1985 Water (Fluoridation) Act* as 'flawed legislation'. As a result, in a resolution passed by a free vote, Parliament passed new legislation in 2003.<sup>7</sup> Section 58 of the *Water Act 2003* states:

*If requested to do so by a relevant authority, a water undertaker **shall** enter into arrangements with the relevant authority to increase the fluoride content of the water supplied by that undertaker to premises specified in the arrangements.*

The replacement of the word 'may' from the earlier Act by the word 'shall' was the critically important change. Section 58 also put new emphasis on the requirement for public consultation before any new fluoridation scheme is requested (or an existing scheme terminated). Regulations are to be drawn up on consultation and assessment of public opinion. Water companies have always been indemnified by the Government in respect of liabilities that they may incur in respect of fluoridation, and the new Act provided for Regulations to be drawn up governing future indemnities. The new legislation has requirements for monitoring of the health impact, not only of new schemes, but also existing water fluoridation schemes. It remains to be seen how successful the most recent changes of legislation have been. Attention is drawn to events occurring in South Central SHA where the outcome of a public inquiry was the decision by the SHA to initiate a water fluoridation scheme in Southampton pending a judicial review. It should also be noted that the recent White Paper on NHS reform will result in the abolition of Primary Care Trusts and Strategic Health Authorities. This may have an impact on the South Central SHA review and any future proposed fluoridation schemes.

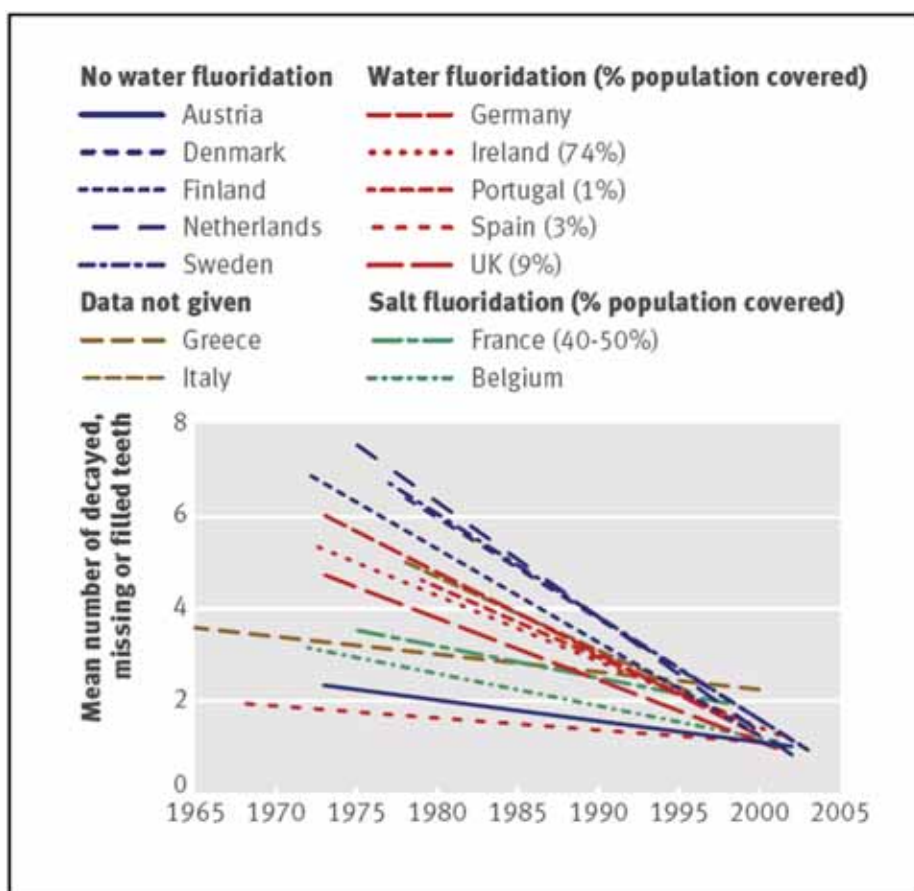
## The objections and the evidence – York and MRC

Those that oppose water fluoridation have a loud voice. A simple internet search will reveal a large number of groups against the use of fluoride. The websites are filled with articles and reviews that purport the dangers of fluoride, often with support from individuals described as eminent scientists and institutions. The various groups do not necessarily agree with one another, but they share some arguments against water fluoridation, including several key issues. Quite often, the different groups are formed by the same small group of individuals. The arguments against water fluoridation are wide and varied. It is beyond the scope of this article to discuss each and every objection to water fluoridation. The main themes of the objections include, but are not limited to:

1. The fact that fluorine and fluoride compounds are toxic and may act as a cumulative poison;<sup>8-10</sup>
2. The fact that fluoride is linked to increased prevalence of cancers, bone disorders, mental disorders and is a danger to certain 'at risk' groups, such as renal patients;<sup>8,10,11</sup>
3. The fact that opponents also cite the chemicals used in water fluoridation, labelling them as hazardous waste products that would have to be disposed of under strict and expensive regimes if they were not simply dumped in to our water supply;<sup>8,10</sup>
4. The fact that there is a claim that compounds that are used in artificial fluoridation schemes do not have the same properties as calcium fluoride found in naturally fluoridated water;<sup>8,10</sup>
5. The fact that some will argue that fluoridation simply does not work and that caries levels have fallen by similar degrees in both fluoridated and non-fluoridated communities;<sup>8,10</sup> and
6. The fact that, in some cases, caries levels are increased in areas with high levels of fluoride in the water.<sup>8,12</sup>

All of these points can be argued, but it should be stated that it is far more difficult to prove scientifically that something 'will not happen', such as developing fluorosis on exposure to fluoride, than demonstrating that a risk of fluorosis exists when exposed to fluoride. Taking each in turn:

- The points highlighted in 1 and 2 above



**Figure 1.** Tooth decay in 12-year-olds in European Union countries. From Cheng K K *et al.* *Br Med J* 2007; **335**: 699-702. (By kind permission of BMJ Publishing Group Ltd).<sup>22</sup>

can be addressed by the fact that, despite the fact that water fluoridation schemes have been in place for over 50 years, no major study or review has unequivocally concluded that water fluoridation, at an optimal level, has resulted in an increase in the prevalence of any of the conditions cited.<sup>13-18</sup> However, there remains the caveat that, in many areas, further research is required to strengthen the evidence base.

■ Any discussion regarding point 3 above is a moot point. The chemicals used in water fluoridation schemes are produced during the manufacturing processes involved in the fertilizer industry. However, simply labelling them as waste products is not entirely true. Co-products or by-products could be a more accurate description. The chemicals are hazardous at the concentration levels at which they are produced, transported and stored, but not at the diluted levels found in the water supply. It has been suggested,

by the anti-fluoridation lobby, that the safety of fluorosilicates has never been investigated.<sup>8,10</sup> However, a report was commissioned by the National Institute of Sciences to address this issue<sup>19</sup> and concluded that, at the recommended levels, fluorosilicates were safe as agents in water fluoridation. An independent report by the Water Research Centre (WRC) looked at the chemistry and safety of fluorides in drinking water, and it also concluded that the water fluoride concentration was safe at the optimum levels.<sup>20</sup> Irrespective of the semantics, the chemicals involved in water fluoridation must comply with stringent regulations (as previously discussed).

■ The issue to be taken up with point 4 is that of the bioavailability of fluoride compounds in water supplies. A study to examine the bioavailability of fluoride between water with naturally occurring fluoride and artificial fluoridation found that, if any differences did exist in the

bioavailability of the fluoride, whether it was natural or artificial, present in either hard or soft water, they would be irrelevant when compared to subject variation.<sup>21</sup> This study was criticized for having a relatively small sample size and for the conclusions that it raised.<sup>22</sup> However, the results of this study are consistent with those found in other reports that there is no difference in the bioavailability of natural and artificial fluoride in water.<sup>14,19,20,23</sup> The authors subsequently responded to criticism of the paper.<sup>24</sup>

■ The criticisms raised in point 5 are rather more interesting to analyse. It is true that the initial benefits that were seen when water fluoridation schemes were implemented appear to have diminished with time. This is largely owing to the advent of freely available alternate sources of fluoride, particularly fluoridated toothpastes.

There has been a steady decline in caries prevalence in Europe in both fluoridated and non-fluoridated communities over the past few decades, according to figures published by the World Health Organization (Figure 1). This has resulted in smaller differences between the two groups. Despite studies showing the reduction in caries in fluoridated communities, and an additional effect of water fluoridation plus fluoridated toothpaste use,<sup>25</sup> it is becoming increasingly difficult to control such studies for confounding factors such as fluoride from other sources, including diet, socio-economic status and population migration. Furthermore, consideration must be given to the 'halo effect' resulting from diffusion of foodstuffs and beverages prepared in fluoridated areas being consumed in non-fluoridated areas.<sup>26</sup> The fundamental question remains to be answered - does water fluoridation continue to have a benefit above the use of fluoridated dentifrices alone?

■ By looking at the extreme situation raised in point 6, some of the protagonists in the anti-fluoridation lobby have been accused of less than honest behaviour, misquoting or misrepresenting conclusions from the literature, and have been reported as overstating their point where negative outcomes have been reported.<sup>22</sup> There have been occasions where data in the literature have been misquoted or misrepresented.

One case in point involved a large 400,000 subject survey in India looking at caries, high levels of fluoride in water and calcium nutrition.<sup>12</sup> The anti-fluoridation lobby not only highlighted the severity of fluorosis (a point that was obvious, as it is endemic in this region), but also reported that the prevalence of dental caries was higher in a population that was fluoridated than a non-fluoridated population. The anti-fluoridation lobby stated that fluoride was not only dangerous but was ineffective at reducing caries.<sup>8</sup> Closer examination of the original paper reveals that this fact, taken in isolation, was true. However, what the anti-fluoridation lobby failed to add was that, in the population with endemic fluorosis where the caries rates were higher, the authors reported that there was also widespread calcium deficiency associated with reduced calcium intake, and the higher caries was linked not only to the deficiency of calcium but also the combination of this with excessive fluoride. The paper concluded that caries control in this region should be modelled on water fluoride levels <0.5 ppm and adequate calcium nutrition (>1 g/day).

Another example cited as demonstrating an increase in caries levels with water fluoridation is a study performed by Ekanayake in Sri Lanka,<sup>27</sup> who examined the prevalence of caries and enamel defects in populations drinking differing concentrations of fluoride in drinking water. The study did find that there was an increase in caries prevalence linked to the severity of diffuse enamel opacities, and that there was an increased risk to caries in those with severe enamel defects when the water fluoride concentration was >0.7 mg/l. The conclusion was that the appropriate level of water fluoride concentration should be 0.3 mg/l in this region. Ekanayake, in a later paper, stated that there was a need to identify factors other than water fluoride concentration contributing to the severity of enamel defects.<sup>28</sup> A similar conclusion was found by Grobler<sup>29</sup> in South Africa. Although once again the study is cited for an increase in caries where there is fluoride in the water, the conclusion of the study is that there was lower caries experience in a community with lower levels of water fluoride. None of the studies cited by the anti-fluoridation lobby as showing higher caries (with water fluoride) included areas

where there was an area with no water fluoride as a control. The data does show an increased prevalence of caries where there were excesses of fluoride but, where the fluoride level is considered optimal for the region, there are decreases in caries experience. It should also be stated that nobody advocates water fluoride concentrations at such high levels as a means of preventing caries.

Individuals within the anti-fluoridation lobby have attracted attention. In his summary of the case of Mrs Catherine McColl v Strathclyde Regional Council, Lord Jauncey criticized the principal witness for the plaintiff. In his summary Lord Jauncey commented that the witness...

*... who played so prominent a part in this case is undoubtedly a propagandist as well as a scientist... but I was driven to the conclusion that he not infrequently allowed his hostility to fluoridation to obscure his scientific judgement... displayed great ingenuity and a very fertile mind during his evidence.*

This was a measured opinion on an individual who was a prominent figure in the anti-fluoridation lobby. Nevertheless, those who oppose fluoridation are often dismissed by some in the scientific community as scaremongers and 'quacks'.<sup>30</sup>

Opponents of fluoridation state that the addition of fluoride compounds into community drinking water takes away individual choice and amounts to mass medication. Such opposition has a loud and influential voice, often with the support of politicians and political parties.<sup>31</sup> The arguments of freedom of choice and adopting a position whereby water fluoridation is mass medication are certainly legitimate points worthy of debate. Every opponent of water fluoridation cites that it is a violation of the individual's rights.<sup>8,10,22,32,33</sup> These rights are judged to be laid down in the European Convention for the Protection of Human Rights and Dignity of the Human Being with Regard to the Application of Biology and Medicine; Convention of Human Rights and Biomedicine. The British Government has not yet signed to the whole of this convention. However, under the European Charter of Fundamental Rights, there is a possibility that the veto may be removed.

Of course, this would only hold true if water fluoridation were judged to be a medicinal product. Those that oppose fluoridation claim that it amounts to mass medication without consent, without correct dosage and without products tested to pharmaceutical standards. At present, the regulatory body, The Medicines and Healthcare Products Regulatory Agency (MHRA) are not responsible for regulating drinking water. This falls within the remit of the Drinking Water Inspectorate through *The Water Supply (Water Quality) Regulations 2000*,<sup>34</sup> not the *Medicines Act (1968)*. This provides a subject of great debate as the regulatory status of water fluoridation and the arguments of the opponents form the cornerstone to the legality of water fluoridation within the UK.

There is an important distinction that must be made between the scientific debate of the safety and efficacy of water fluoridation and the moral implications of such public health policies. If we were to assume that water fluoridation was safe and effective, then there still remains a moral question relating to beneficence and autonomy.<sup>35</sup> Does the overall benefit to a population outweigh the right of an individual to choose? Lord Avebury adopted the position that the civil liberties and rights that are referred to by those who oppose water fluoridation do not give an individual the 'right to dictate the chemical composition of the water supply'.<sup>36</sup>

The compulsory wearing of car seatbelts, the fortification of foods, prenatal blood tests for genetic conditions and vaccination programmes are examples whereby individual rights can be judged to have been removed in what are accepted public health or safety policies. Some may argue that there is a difference between preventing communicable disease and preventing dental caries. However, the end goal is the same - an attempt to reach those at risk and the reduction in treatment costs that could have arisen. This is especially true for a public funded healthcare system such as the NHS. This is a brutal point but, unfortunately, a relevant one when we live in a society of fixed budgets for healthcare provision. Is it not just as unethical to ignore the potential for prevention, cost-effectiveness and the reinvestment of monies where it is needed most? There appears to be no escape from this position

of beneficence and autonomy, even if there were no risks associated with fluoridation.

Political opposition and the subject of personal choice are not the only obstacles for the implementation of water fluoridation. Geographical limitations may occur, such as conflict between the boundaries of water companies and those of health authorities, which can create problems where one health authority requests fluoridation, but water treatment plants and supply overlap into another health authority not requesting fluoridation. If the supply of water to a region is fragmented and divided between numerous water treatment plants, inadequate infrastructure may reduce the cost-effectiveness of implementing water fluoridation. Under these circumstances, it is often advisable to seek alternative public health policies. For example, France has over 20,000 separate public water sources. This would make water fluoridation technically difficult to implement. Under these circumstances it is more appropriate to seek alternative means of fluoride delivery. In Europe, for example, there is extensive use of fluoridated salt.

#### The York Report

There have been attempts to address the issues surrounding water fluoridation. The Department of Health (DoH) commissioned a systematic review on water fluoridation that was published in September 2000. This report was carried out by the Centre for Reviews and Dissemination, University of York and became known in the dental research community as the York Report.<sup>18</sup> The York Report was commissioned by the Chief Medical Officer to 'carry out an up to date expert scientific review of fluoride and health'.<sup>37</sup> It was hoped that it would be the final word on water fluoridation. There were five key objectives of the review:

- To examine the effects of fluoridation of water on the incidence of caries.
- To examine any effects of water fluoridation (if any) over and above those offered by alternative interventions and strategies.
- To examine if water fluoridation results in caries reduction across social groups and geographical locations, bringing equality.
- To examine if negative effects of water fluoridation exist.

- To examine if there are differences in the effects of natural and artificial water fluoridation.

The report concluded that, despite the fact that current research on fluoridation supported the benefits of water fluoridation, certain aspects within the evidence base were not acceptable, and the York Report commented that future research should address these issues. The report also stated that the evidence base did not permit confidence in statements relating to potential harm or the impact on social inequalities. The report also concluded that future research should be 'considered along with the ethical, environmental, ecological, costs and legal issues that surround any decisions about water fluoridation'.

The report was met with mixed reaction. Both sides of the fluoridation debate criticized the report's contents and conclusions. Those who advocated fluoridation were disappointed that vast amounts of evidence illustrating the benefits of water fluoridation were omitted because the scientific standards of the day did not meet the strict standards required of more contemporary work. However, they were pleased with the report's conclusions that there was a clear benefit on caries levels. Opponents of fluoridation were disappointed that research was omitted from the review owing to the inclusion criteria set out for the review.<sup>8</sup> Data from reviews and commentaries were excluded, as were data from animal studies. They were also disappointed that the review looked at the effects of artificial water fluoridation and not fluorides from other sources. There was also concern that there had been no investigation of fluoride absorbed through the skin. The York Report failed to deliver the 'knock-out punch' that both sides had been hoping for.

#### The MRC Report

Following the York report, a Medical Research Council (MRC) publication, *Water Fluoridation and Health*,<sup>13</sup> also issued guidance on the research shortfalls in fluoride research and again recommended that this be a priority area for research in the future. The report also highlighted the need to examine the total fluoride exposure of individuals, owing to the fact that potential exposure has

increased as more dental healthcare products contain fluoride.<sup>38-40</sup> Furthermore, the report recommended research into possible differences in fluoride uptake from naturally fluoridated water and artificially fluoridated water and to determine the impact of the level of water hardness on the bioavailability of fluoride.

The MRC also recommended that fluoride exposure in children should be examined to identify the impact of water fluoridation on the reduction in caries against a background of wider fluoride exposure from alternative sources, especially toothpaste. Greater knowledge is needed on how the effects of water fluoridation vary with social class; a link between dental caries prevalence and socio-economic status has been generally accepted.<sup>40,41</sup> The majority of the literature to date suggests that water fluoridation may reduce dental caries inequalities between high and low socio-economic groups.<sup>42</sup> The MRC report recommended that research focused on appropriate measures of social inequalities related to water fluoridation, dental caries and fluorosis, taking into account factors such as the use of other fluoridated products, such as toothpaste and dietary sugar ingestion.

Although the majority of research has concentrated on children, future research should not ignore the effects of fluoridation on dental health in adults, in addition to possible health outcomes (other than dental health) related to water fluoridation. The risk of hip fracture is the most important in public health terms. Early evidence on this suggests no effect, but is not conclusive,<sup>43</sup> although a more recent study concludes that long term exposure to fluoride in drinking water did not increase the risk of fracture.<sup>44</sup> Similarly, available evidence of the impact of fluoridation on other bone disorders is not unequivocal owing to the paucity of available data.

Another issue raised by the MRC is the possible role of fluoride and fluoridation on cancer incidence. Although the MRC stated that the evidence suggests no link between water fluoridation and either cancer in general or any specific cancer type (including osteosarcoma, primary bone cancer), an updated analysis of UK data on fluoridation and cancer rates

is recommended in the report. This aspect will be covered by the implementation of a surveillance programme.

#### The Environmental Protection Agency

In the United States, the Environmental Protection Agency (EPA) is responsible under the Safe Drinking Water Act to set and monitor the maximum exposure levels for contaminants in public water supplies. The remit of the report was not to investigate the safety of water fluoridation, but to examine fluoride at levels where it would be considered as a contaminant. The standards include the maximum contaminant level goal (MCLG), the maximum contaminant level (MCL) and the secondary maximum contaminant level (SMCL). The MCLG is set at a level at which no adverse health effects can be expected to occur with 'adequate' margins of safety. The enforceable standard is the MCL and is set as close to the MCLG as practicably possible. The SMCL is set by the EPA in circumstances of managing aesthetic, cosmetic or technical effects. Fluoride is one of the contaminants regulated by the EPA. Periodically, the EPA is required to review these standards. In 1986, the EPA set an MCLG and MCL for fluoride of 4 mg/l and a SMCL of 2 mg/l. It must be stressed that the EPA's work on this matter is not a means of assessing the safety or efficacy of water fluoridation in the reduction of dental caries, those standards were set for that purpose by the US Public Health Service at a range of 0.7-1.2 mg/l. The EPA's remit is to provide guidance on maximum allowable concentrations in drinking water from natural sources and artificial sources in order to prevent adverse or toxic effects that could result from exposure to fluoride.

#### The NRC Review

The National Research Council (NRC) published the latest review of the EPA's standards in 2006.<sup>14</sup> The NRC examined the evidence (including animal model data that was excluded from the remit of the York Report) covering fluoride exposure, dental effects, musculoskeletal effects, reproductive and developmental effects, neurotoxicity, endocrine effects, genotoxicity and carcinogenicity. The report was a comprehensive examination of the evidence available.

In summary, the NRC did

find that there were some groups whose fluoride intake would be higher from water than most of the population, eg athletes, outdoor workers and diabetics. The committee also concluded that severe enamel fluorosis could be classed as being more than merely cosmetically unacceptable. The balance of evidence across all of the areas investigated suggested further research in these fields was necessary and, in light of this, that the MCLG of 4 mg/l fluoride in drinking water should be lowered. The committee did not comment on the safety of water fluoride levels set for the purpose of preventing dental caries. However, this has not prevented some bodies, such as the National Pure Water Association, from citing the results from the NRC Report as evidence that water fluoridation is not safe. To suggest that, because more evidence is needed to assess a MCLG of 4 mg/l fluoride, that a level of 1 mg/l (1 ppm) fluoride is therefore unsafe, is a little overcautious, and perhaps a misrepresentation of the conclusions of the NRC.

### What is the way forward for water fluoridation?

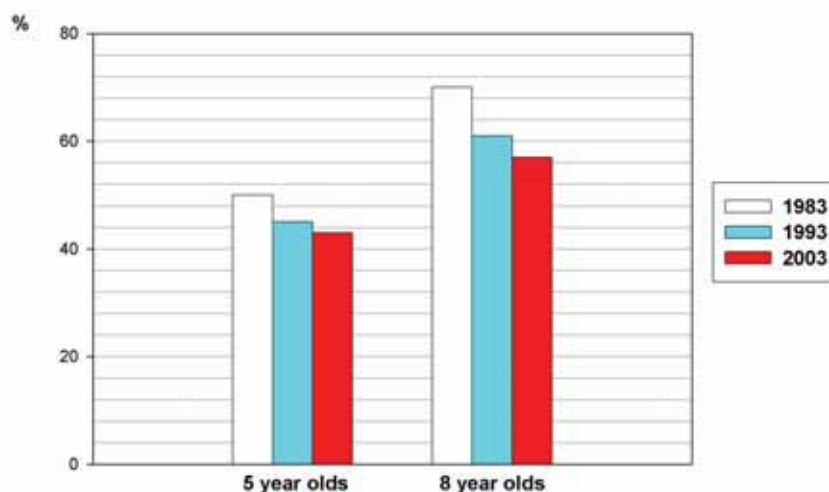
The obvious statement to make would be that the opposing sides in the fluoridation debate need to find common ground. This may not be as difficult as it sounds. There are concessions that can be made by both sides. The common goal is the welfare of the patient, whether that is taken at an individual or population level. The ethical arguments of each side should be considered as fairly as those from the opposing side. Dentists could, and should, be better informed of the uses and abuses of fluoride. Their education on fluoride should be more comprehensive at undergraduate level and continue through to postgraduate level, encompassing current evidence and the development of standard practices to maximize benefit and minimize risk, particularly in vulnerable groups.

Scientists and researchers, whether they are for or against fluoridation, should not allow their own feelings to overwhelm their work and thus prevent it from becoming propaganda that can be easily dismissed. Instead, research should continue to be evidence driven

and peer reviewed, not merely an opinion. Science should not be simply dismissed if a conclusion differs from the norm, but challenged with reasoned and just argument, not sound bites and propaganda designed to frighten or patronize the public.

Researchers need to address the issues raised by such reviews as the York Report, the MRC Report and the NRC Report. There is no denying that the evidence base needs to be improved and the legal position as to whether or not it amounts to medication clarified. If it is to continue and expand we need to provide evidence that water fluoridation continues to be effective above the use of fluoridated dentifrices alone, using methodologies that minimize bias and are more objective than traditional subjective indices. Techniques and technologies are available and continue to be developed to measure and quantify dental caries and enamel fluorosis.<sup>45-51</sup> The effects of a changing society, with its changing social norms, diet and changing demographic and socioeconomic status need to be accounted for when looking at prevalence levels of caries and fluorosis.<sup>42,52-55</sup> Notwithstanding the necessity to obtain sufficient evidence for the safety and efficacy of water fluoridation, we also need to continue to look for alternative solutions. Not only if it is deemed unsuitable, but for areas where it is impractical to implement.

It is also necessary to examine the changing patterns of dental caries, how we record and report the findings of research and how we use the data to commission healthcare provision and targeted or focused delivery of fluoride. Despite the fact that caries levels in the UK are falling as a whole, this cannot be said of individual groups, whether in particular age groups, geographical areas, or differing social classes. The Children's Dental Health Survey 2003 did demonstrate an overall fall in caries levels. However, the fall in levels for 5 and 8-year-olds failed to demonstrate significant improvements (Figure 2). (It should be stated that the 2003 survey included visual dentine caries scores for the first time and scores were adjusted to the old scoring criteria for comparison with data from earlier surveys. It provided a more up to date measure of caries experience but any change in the trend will not be known until the next survey in 2013). The reasons



**Figure 2.** Percentage of children with obvious decay experience in primary teeth. Data from Children's Dental Health Survey in the UK 2003.

for this apparent lack of improvement need to be addressed.

Once we have satisfied the situations outlined above, we can begin to debate the moral and ethical dilemmas that surround water fluoridation. This debate needs to be balanced on either side of the argument and not restricted to scientists, politicians and lawyers. There is a need to engage public consultation properly and to examine the social and sociological issues behind the arguments.<sup>56</sup>

### The future of water fluoridation in the UK - why is it still important?

Whilst it is clear that there are no quick solutions to the issues facing water fluoridation, the overall position is not insurmountable. It is hoped that evidence will continue to support the continuation of existing fluoridation schemes, where they are deemed necessary. It is a paradox that, in answering the questions raised by York and the MRC, a new fluoridation scheme would need to be implemented in order to provide research that would meet the criteria required to produce valid data. It would also be hoped that clarification of evidence and continued research will provide an evidence base for the extension of water fluoridation schemes in the UK, again, where it is deemed appropriate. This can only occur with the co-operation of

politicians, science and the general public engaging in open, unambiguous and fair consultation. We await the fate of the proposed scheme in Southampton, the outcome of which will have ramifications elsewhere in the country.

Numerous studies and reviews have examined the use of fluorides in caries prevention in children and in adults. The evidence is not conclusive but suggests that the most appropriate way of preventing dental caries is through oral hygiene education, home use of fluoridated dentifrices and the appropriate use of topical fluoride as part of a professionally applied process.<sup>57-63</sup> However, this is an active form of intervention that requires the compliance of the patient. The fact remains that if a 80:20 model of dental caries<sup>64,65</sup> is true, or the pattern follows a similar trend, where the majority of the disease exists in a small percentage of a population, it may prove difficult for behaviour change alone to work as a cost-effective population based on a dental public health model. This is further confounded if assumptions based around a 80:20 model are not true.<sup>52,66</sup> This would be particularly true of a population where this cohort belongs to a group of infrequent or non-dental attendees. Recent work has suggested that the risk of a child developing caries is increased with age and, once the disease is contracted, the risk of developing new lesions increases further compared to caries-free children.<sup>67</sup> Without

the ability to assess caries risk accurately, we must approach preventive measures on a whole population basis. This means that we should not approach the care of caries-free children and those with caries experience as separate populations. Those who initially attend as caries free cannot be assumed to remain caries free. All patients, irrespective of age, should be encouraged to perform effective oral hygiene, twice daily with appropriate fluoride-containing dentifrice.

There is also a difference between efficacy and effectiveness. Products or interventions can have efficacy demonstrated in clinical trials, but this might not provide answers for the more general or pragmatic evaluation of use in practice.

Despite its flaws, water fluoridation remains a cost-effective population-based dental public health intervention. It is non-discriminatory, passive and has the potential to reach more people in need.<sup>63</sup> It may be less efficacious, in principle, than behaviour change, but it could prove more effective in the longer term and provide a more favourable outcome in terms of health economics. In combination with agreed common practices or protocols on the use of other fluoridated products (consumer and professional), water fluoridation may still provide an appropriate adjunctive solution to continuing high caries prevalence in certain populations, whilst minimizing adverse effects, such as fluorosis. Recent studies have shown that it is possible to maintain improvement in caries levels with fluoridated dentifrices in areas with the complexity of water supplies that contain varying levels of fluoride, whilst putting in place policies designed to reduce the prevalence of severe fluorosis.<sup>68</sup> This can be obtained through practical advice that engages not only dental professionals, but also other healthcare workers, teachers, parents and patients. If such policies can work in areas where they need to address not only variable but high levels of fluoride in the water, then it is not insurmountable to implement similar policies to areas with targeted fluoridation schemes aimed at addressing high caries level populations, such as the North West of England.

Further information on the use of fluorides in dentistry and the water fluoridation debate can be found

at the British Fluoridation Society website at [www.bfsweb.org](http://www.bfsweb.org). Information on the National Pure Water Association campaign for safe, non-fluoridated water can be found at [www.npwa.org.uk](http://www.npwa.org.uk). The National Fluoride Information Centre (NFIC) is an independent academic unit that provides objective information on the use of fluorides in dentistry. Their website can be found at [www.fluorideinformation.com](http://www.fluorideinformation.com)

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