

# The cost and cost-effectiveness of water fluoridation

## KEY POINTS

- **The World Health Organisation states that: “Community water fluoridation is safe and cost-effective and should be introduced and maintained wherever it is socially acceptable and feasible.” (1)**
- **Studies suggest that, in terms of cost, effect and the certainty of that effect, the most cost-effective policy for reducing tooth decay is fluoridation of water supplies.**
- **The higher the incidence of tooth decay before fluoridation starts, and the larger the population to be served, the greater the economic benefits are likely to be.**
- **In the parts of the UK where tooth decay remains a significant public health problem, patients and the NHS economy would benefit hugely from water fluoridation.**



# 1. Meeting the costs of fluoridation

## Public health measure paid for by the NHS



Water fluoridation is a public health measure specifically intended to improve dental health and, by so doing, to contribute to the overall improvement of people's health and well-being. As such, it is paid for entirely from funds currently available to the National Health Service.

As decisions about whether to fluoridate water supplies are taken locally by NHS Strategic Health Authorities (SHAs), it is they who pay the bills issued by water companies operating fluoridation schemes at their request. The money used for this purpose is found from health promotion budgets held by local Primary Care Trusts (PCTs).

Where the populations of several PCTs receive fluoridated water from the same source, the contributions made by those PCTs towards the costs of operating the scheme reflect the relative numbers of people within each PCT who are benefiting from the scheme.

## Capital expenditure and running costs

Fluoridation schemes require capital expenditure to install plant and equipment and to replace and upgrade those facilities when necessary. There are also annual running costs to meet. Both the capital and running costs vary, depending on the size of the population served by a particular scheme.

Up to now, grants have been available from the Department of Health to help cover the capital costs of introducing new fluoridation schemes and major upgrades of plant and equipment for schemes that have been in operation for some time.

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Solihull cost 16 pence per  
head.*

In a consultation conducted in 2008/09 by South Central Strategic Health Authority on proposals to fluoridate water supplies to 195,000 people in Southampton and neighbouring parts of Hampshire, the initial capital cost of installing the plant and equipment needed was estimated at £471,000. Annual running costs were estimated at around £59,000 a year (30 pence per head of population).

The more people supplied with fluoridated water from a single water source, the proportionately cheaper the scheme becomes. The largest existing scheme in England supplies fluoridated water to some 1,175,000 people in Birmingham and parts of neighbouring Solihull. In 2007/08, the running costs worked out at £183,000 or 16 pence per head.

Given the coalition government's proposals to abolish Strategic Health Authorities and Primary Care Trusts from April 2013, the health promotion resources currently devoted to water fluoridation will need to be transferred to whichever organisations are made responsible for overseeing those schemes.



## 2. Calculating cost-effectiveness

### Value for money

The purpose of fluoridation is to reduce tooth decay, promote good oral health and prevent any unnecessary pain, discomfort and anxiety that may arise from tooth decay. Clearly, as with any other public health measure, the aim is also to achieve health improvements as cost-effectively as possible.

As well as having responsibilities for preventing disease and reducing health inequalities, local NHS bodies also have financial duties that require them not to spend more money than is allocated to them from the public purse. For this reason, they need to use their resources wisely and obtain 'value for money'. The measures in which they invest must therefore be as cost-effective as possible.

### Effectiveness of fluoridation in reducing tooth decay

The effectiveness of water fluoridation in reducing tooth decay has long been established from individual studies comparing dental health in fluoridated and non-fluoridated communities (see section of this report on the Dental Benefits of Fluoridation).

Systematic reviews of the worldwide evidence published between 2000 and 2007 have confirmed that fluoridation does, indeed, reduce both the severity and prevalence of tooth decay.

The York review found an average reduction of about 40% in the average number of decayed, missing and filled teeth per child in fluoridated areas compared with non-fluoridated areas, and an increase of around 15% in children with no experience of tooth decay (2).

A US Task Force review estimated average reductions in tooth decay in children of between 30% and 50% (3), whilst a review of previous studies of adults found that, on average, those who had lived all their lives in fluoridated areas had between 27% and 35% fewer decayed, missing and filled teeth than those who had always lived in non-fluoridated areas (4).

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## Cost-effectiveness of fluoridation by comparison with alternative strategies for promoting dental health

To assess the cost-effectiveness of water fluoridation it is necessary to consider whether, in relation to alternative methods, it provides the greatest benefit for a given expenditure, or whether the value of the benefits exceeds the value of the costs (5).

Whilst surprisingly little is known about the cost-effectiveness of many common healthcare interventions (6), the cost-effectiveness of water fluoridation has been studied extensively over many years (7-17). Indeed, a 1994 study by the University of York Health Economics Consortium of strategies for reducing tooth decay concluded that: "...in terms of cost, effect and the certainty of that effect, the most cost-effective policy is fluoridation of water supplies." (15)



### Further study by University of York Health Economics Consortium (1998)

In 1998 the University of York Health Economics Consortium undertook a further, detailed examination of the costs and benefits of water fluoridation (18).

The study recognised that, overall, levels of tooth decay had improved dramatically since the 1960s when fluoridation was first introduced in Britain. However, it highlighted the significant variations in dental health across Britain that had become apparent as tooth decay in the general population had fallen. Recognising these variations, the study identified 'the range of possible benefits that would be associated with extending fluoridation into certain areas under certain assumptions'.

## Key findings of the 1998 York Health Economics Consortium study

The York Health Economics Consortium study identified four key variables to be considered in evaluating the cost-effectiveness of water fluoridation:

- the size of the population;
- the level of tooth decay in the population;
- the age and condition of the water treatment works; and
- the type of fluoride to be used.

The report's main findings were:

- Studies comparing the cost-effectiveness of water fluoridation with that of other strategies for reducing tooth decay always conclude that **water fluoridation is the most cost-effective approach**.
- One of the greatest strengths of water fluoridation is that **it does not require any behavioural changes from its recipients**.
- **The scale of the effect of campaigns to change behaviour cannot be predicted**, and such campaigns may fail to influence those who would benefit most from them. **It is, however, possible to predict the costs and benefits with water fluoridation**, and to be confident that those people likely to benefit the most from it will do so. Furthermore, the costs are borne by the NHS, and no private contribution is required.
- **Calculating the capital and revenue costs of fluoridation for a population of a particular size is relatively straightforward**, although these costs have to be discounted to determine the equivalent annual cost over each year of the installation's life (discounting allows the capital cost to be depreciated over the period). From this, an equivalent annual cost per person of fluoridation can be calculated and, indeed, a ready-reckoner devised to determine this for populations of different sizes, and plants with different capital and revenue costs.



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- **The approach used in this study to calculating the benefits of fluoridation draws upon work undertaken by Sanderson and Wilson (18) for Yorkshire data**, based on the methodology of Birch (13), which identifies the expected reduction in tooth decay each year for children receiving fluoridated water from birth until they reach 14 years of age.
- Using population projections and knowledge of underlying oral status, **it is possible to predict the numbers of decayed teeth, fillings and extractions that will be prevented each year of the life of the fluoridation installation** (i.e., 14 years) for children born after fluoridation.
- **A monetary value can then be assigned to these 'benefits'**, which are also discounted over the period to estimate the annual equivalent 'saving'.
- It should be noted that **these calculations only consider the benefits to people born after the fluoridation of the water supply**. However, those born prior to fluoridation will also benefit, although to a lesser extent. For example, adults would have less decay on exposed root surfaces, and young children would have less decay in their permanent teeth. Because of the difficulties associated with quantifying such benefits, these have not been included in the calculations, but their omission means that the benefits of fluoridation are underestimated in the model.
- **As the size of the population served by the fluoridation plant at a particular water treatment works increases, the cost per person of fluoridation decreases**. The larger the population served, therefore, the more cost-effective fluoridation becomes.

## An economic evaluation of community water fluoridation by Griffin et al (2001)



An economic evaluation of fluoridation by a group of US researchers was published in the Journal of Public Health Dentistry in 2001 (19). They based their calculations on the epidemiological evidence that tooth decay in children (aged 6 and over) and adults (up to 65 years old) would be reduced on average by 25%. They also calculated for a 'worst case' scenario based on only a 12% average reduction in tooth decay, and a 'best case' scenario based on a 29% average reduction.

The costs of fluoridation included capital expenditure on plant, equipment and consultant engineering fees, together with annual operating expenditure on fluoride materials, labour and maintenance. These were then offset against reduced expenditure on dental treatment, based on the average price of \$54 for the filling of a single decayed tooth surface reported by the American Dental Association in 1995. The wider costs to society of dental treatment, including time taken off work, were also taken into account. This resulted in a total cost of \$72 for the filling of a decayed tooth surface.

Using this approach, the US team estimated that the reduction in the cost of restorative dental treatment exceeded the cost of fluoridation in communities of all sizes and in all scenarios based on assumed reductions of tooth decay from 12% to 29%.

At the 12% level (worst case scenario) of tooth decay reduction, the team found that the annual cost savings of fluoridation ranged from \$0.85 per person per annum in communities of less than 5,000 people to \$3.52 per person per annum in communities of more than 20,000 people.

At the 25% level of tooth decay reduction, the team found that the annual cost savings of fluoridation ranged from \$15.95 per person per annum in communities of less than 5,000 people to \$18.62 per person per annum in communities of more than 20,000 people.

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At the 29% level (best case scenario) of tooth decay reduction, the team found that the annual cost savings of fluoridation ranged from \$31.04 per person per annum in communities of less than 5,000 people to \$33.71 per person per annum in communities of more than 20,000 people.

The US researchers stressed in their report that the magnitude of the cost savings resulting from fluoridation will depend on a variety of factors related to the population to be served by a new scheme. The higher the incidence of tooth decay before fluoridation starts, and the larger the population to be served, the greater the economic benefits are likely to be.

However, they pointed to the complications arising from the fact that some populations nominally in non-fluoridated areas of the United States could already be receiving a 'diffused benefit', which may result from the widespread distribution in non-fluoridated communities of bottled and canned drinks manufactured in fluoridated communities.



## Abacus International economic evaluation for South Central Strategic Health Authority (2008)

As part of its preparations in 2008 to launch a public consultation on proposals to fluoridate water supplied to 195,000 people in Southampton and parts of neighbouring Hampshire, South Central Strategic Health Authority commissioned Abacus International to undertake an economic evaluation of the costs and benefits.

Working from the average levels of tooth decay in Southampton among 5-year old children in 2005/06 and 12-year old children in 2004/05, the Abacus team calculated the likely reduction in tooth decay rates among children born after fluoridation of the city's water supplies (20).



The team assumed that, up to and including the age of 17, fluoridation would reduce decay by an average of 25% in this group of children, compared with the levels of decay they might otherwise have experienced. Both primary and permanent teeth were included in the calculations. Adults were excluded from the analysis.

In developing its economic model, the Abacus team took account of the cost of installing and running a fluoridation scheme in Southampton over the anticipated 20-year life span of the plant and equipment. This figure was estimated at £1.49 million. This was offset against an estimated reduction in dental treatment costs of £1.48 million over the same period (based on 36,032 instances of tooth decay prevented as a direct result of fluoridation).

To calculate the cost of each instance of tooth decay prevented by fluoridation, the Abacus team subtracted the reduced treatment cost of £1.48 million from the total fluoridation scheme cost of £1.49 million. The difference (£10,000) was then divided by 36,032 to produce a cost per instance of tooth decay avoided of £0.32.

As the Abacus report pointed out, if the amount of tooth decay prevented by fluoridation turned out in practice to be less than the 25% presumed in the calculations, its cost-effectiveness would be reduced.

On the other hand, the report also pointed out that by excluding the benefits to adults from the economic model, the cost-effectiveness of fluoridation had probably been under-estimated. In conclusion, the Abacus team suggested that, for the purpose of making a decision about whether or not to implement a fluoridation scheme in Southampton, South Central Strategic Health Authority should treat the economic picture as 'cost neutral'.



## 3. Reducing the burden of dental treatment costs on the NHS

### Tooth extractions under a general anaesthetic

The most common treatment of tooth decay in young children is tooth extraction, which is usually carried out under general anaesthetic (21).

Following a Department of Health Review, and a General Dental Council ruling, from 1 January 2002 all general anaesthetics for dental treatment have had to be performed in a hospital with critical care facilities (22, 23). Whilst this requirement was introduced to enhance patient safety, it makes the treatment of such a common disease particularly expensive, and places a strain on scarce NHS resources.



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### How fluoridation could reduce the high cost of extractions in the North West of England

Tooth decay in young children is a particular problem in the North West of England. Each year, around 1,500 general anaesthetics are administered to children for extraction of decayed teeth in the Manchester Dental Hospital alone. The cost per case is approximately £160, with a total annual cost of £240,000.

However, based on recent studies (24-26), fluoridation of Manchester's water supply could reduce demand for tooth extractions under general anaesthetic by between 35% and 67%, bringing the number of cases in Manchester to between 500 and 1,000 a year.

At today's prices, such a reduction in demand would represent cash savings of between £84,000 and £160,000 per annum - in Manchester alone. Similar savings could be expected in comparable non-fluoridated parts of the country – for example Liverpool, Leeds, Bradford, Inner London, Glasgow, Cardiff, and Belfast.

It is worth also considering the 'opportunity costs' that result from the fact that considerable resources are tied up in hospital general anaesthetic sessions for dental extractions rather than being available for the treatment of conditions other than tooth decay.

In the Manchester Dental Hospital three general anaesthetic sessions take place each week. Each session requires two paediatric anaesthetists, the operating dentist, the consultant paediatric dentist supervising the session, and around 10 support staff. If demand for general anaesthetics for tooth extractions were reduced, much of this human and technical resource could be used to reduce waiting lists and delays for other treatments.



## **Significant differences between the North West and West Midlands**

A comparison of the largely non-fluoridated North West region of England with the largely fluoridated West Midlands reveals significant differences in the pattern of expenditure on general anaesthetic sessions for dental extractions in 0-19 year olds.

For example, analysis of 2007-09 data shows that the directly standardised rate of extractions under general anaesthetic for non-fluoridated Liverpool Primary Care Trust (the second most socially deprived PCT in England) was 27 times greater than the rate for fluoridated Heart of Birmingham Primary Care Trust (the most socially deprived PCT in England).

## The wider social costs of treatment

Of course, none of the above takes account of the costs to the children and their parents – for example, in terms of time lost from school and work. Nor does it take account of the negative impact on the children's health and well-being of having to wait several weeks for treatment, as well as the anxiety of undergoing tooth extractions under a general anaesthetic.

In Manchester, there are generally around 500 children on the waiting list for this treatment. In other words, there are wider costs to society from severe tooth decay than the monetary cost of the treatment itself.

There is little doubt that, in parts of the country where tooth decay remains a significant public health problem, patients and the NHS economy would benefit hugely from water fluoridation.

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