The cost-effectiveness of fluoridating water supplies in New Zealand

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The health technology studied was the introduction of fluoridation (using hydrofluosilicic acid, containing 15% available fluoride) to a water supply to prevent decayed teeth within a population.

Type of intervention
Primary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised individuals from New Zealand (both Maori and non-Maori), aged 4 years or older.

Setting
The setting was a community. The study was carried out in New Zealand.

Dates to which data relate
The effectiveness data were mainly collected from a study published in 1992, although other studies published between 1971 and 2000 were also reviewed. The cost data appeared to be from 1999. There was confusion regarding the price year of the economic analysis since 1999 was reported to be the price year, although some tables reported the costs for year 2000.

Source of effectiveness data
Effectiveness data were derived from a non-systematic review of published studies.

Outcomes assessed in the review
The following health outcomes were assessed in the review: the number of averted decayed surfaces per year due to fluoridation exposure for the non-Maori population; the percentage of all dental restorative work that would require replacement; the annual mean number of averted decayed surfaces in children (from 4 to 13 years) for fluoridated areas compared to non-fluoridated areas, considering both deciduous and permanent teeth surfaces, and Maori and non-Maori populations.

Study designs and other criteria for inclusion in the review
The criteria used to select primary studies from which to extract data were not reported. Several demographic data studies, one case control study, and a review of the literature were included. The databases of the school dental services providers of Wellington and Canterbury were also consulted.
Sources searched to identify primary studies
The sources searched to identify primary studies were not reported.

Criteria used to ensure the validity of primary studies
The criteria used to ensure the validity of the primary studies included in the review were not reported.

Methods used to judge relevance and validity, and for extracting data
The methods used to judge the relevance and validity, and to extract data, were not reported.

Number of primary studies included
At least 12 published studies were reviewed, although the effectiveness estimation was mainly based on one study (see Grembowski et al. in the 'Other Publications of Related Interest' section, below), and the Wellington and Canterbury databases.

Methods of combining primary studies
The authors did not report the method used to combine the primary studies.

Investigation of differences between primary studies
No investigation of the differences between the primary studies was reported.

Results of the review
The number of averted decayed surfaces per year due to fluoridation exposure was 0.29 (95% CI: 0.19 - 0.39) for the non-Maori population.

The percentage of all dental restorative work that would require replacement would be, at least, 60%.

The annual mean number of averted decayed surfaces in children's permanent teeth in fluoridated areas, when compared to non-fluoridated areas, was between 0.034 and 0.570 for non-Maori children aged 6 to 13 years old, and between 0.059 and 1.150 for Maori children aged 6 to 13 years old.

Methods used to derive estimates of effectiveness
Several effectiveness estimates were based on the authors' assumptions.

Estimates of effectiveness and key assumptions
The authors made the following assumptions:

- Optimally fluoridated water supplies do not cause adverse health effects.
- There are no significant benefits after 30 years.
- There is no new averted decay after age 34.
- There is no mortality in the birth cohorts receiving fluoridated water.
- Emigration in the cohort is counterbalanced by immigration.
- The population maintains the same demographic structure during the study period.
Fluoridation occurs at a single point with one delivery pump. 0.33 decayed surfaces will be averted annually for Maoris aged 14 to 34.

**Measure of benefits used in the economic analysis**
The summary measure of benefit used in the economic analysis was the number of averted decayed permanent tooth surfaces due to the fluoridation of water supplies during the study period (30 years: from 2000 to 2030), considering different population sizes (between 1,000 and 300,000 population). This measure appears to have been obtained by combining demographic data with the effectiveness results derived from the non-systematic review. The estimated health benefits were discounted at 5%.

**Direct costs**
The direct costs considered in the economic analysis were the hospital costs incurred to treat decayed teeth (dental restorative work and hourly rate for dentists), and community costs of fluoridating the water supply (capital and annual operating costs, such as equipment and the costs of hydrofluosilicic acid). Some but not all, of the resource quantities were given separately from the costs. The sources of the cost estimation were the average General Dental Benefit fee, a survey of dental charges, information given by the equipment providers and the operators of the fluoridation systems, and several assumptions made by the authors. The estimation of costs was therefore based on both actual data and authors' assumptions. Discounting was appropriately performed at a 5% rate, since the period considered was 30 years. Some cost components corresponding to 1998 were increased by 3% to adjust for inflation. The authors stated that the price year was 1999, although the tables reported costs for the year 2000. The estimated costs reported were the total costs for fluoridation and with non-fluoridation during the study period, and the incremental costs associated with fluoridation, when compared to non-fluoridation.

**Statistical analysis of costs**
No statistical analyses of costs were reported.

**Indirect Costs**
The indirect costs were not reported.

**Currency**
The text uses dollars ($) - we have assumed these are New Zealand dollars (NZS) as the journal is a New Zealand journal.

**Sensitivity analysis**
Two-way sensitivity analyses were carried out in order to assess whether the results obtained were robust when changes in the demographic composition of the population (from 1,000 to 300,000 population) were considered, at the same time as other variations, such as the number of fluoride injection sites (from 2 to 5), or the discount rate (e.g. 10%). Some further, one-way, sensitivity analyses were performed, but their results were not reported in the paper. The areas of uncertainty investigated were therefore variability in data and analytical methods. No justification was given for the ranges considered in the sensitivity analyses.

**Estimated benefits used in the economic analysis**
The discounted averted decay in permanent tooth surfaces during the study period were: 1,480 for a population of 1,000, 7,420 for a population of 5,000, 14,800 for a population of 10,000, 37,100 for a population of 25,000, 74,200 for a population of 50,000, 111,000 for a population of 75,000, 148,000 for a population of 100,000, 297,000 for a population of 200,000, and 445,000 for a population of 300,000 individuals.
Cost results
The following discounted costs were estimated for a 30-year period:

Fluoridation costs were: NZ$156,000 for a population of 1,000, NZ$168,000 for a population of 5,000, NZ$183,000 for a population of 10,000, NZ$228,000 for a population of 25,000, NZ$312,000 for a population of 50,000, NZ$387,000 for a population of 75,000, NZ$462,000 for a population of 100,000, NZ$768,000 for a population of 200,000, and NZ$1,070,000 for a population of 300,000.

Non-fluoridation costs were: NZ$174,000 for a population of 1,000, NZ$870,000 for a population of 5,000, NZ$1,740,000 for a population of 10,000, NZ$4,350,000 for a population of 25,000, NZ$8,700,000 for a population of 50,000, NZ$13,000,000 for a population of 75,000, NZ$17,400,000 for a population of 100,000, NZ$34,800,000 for a population of 200,000, and NZ$52,200,000 for a population of 300,000.

Incremental costs of fluoridation versus non-fluoridation were: -NZ$17,500 for a population of 1,000, -NZ$701,000 for a population of 5,000, -NZ$1,560,000 for a population of 10,000, -NZ$4,120,000 for a population of 25,000, -NZ$8,390,000 for a population of 50,000, -NZ$12,700,000 for a population of 75,000, -NZ$16,900,000 for a population of 100,000, -NZ$34,000,000 for a population of 200,000, -NZ$51,100,000 for a population of 300,000.

Synthesis of costs and benefits
The estimated costs and benefits were not combined in the baseline analysis because fluoridation of water supplies was a dominant strategy, when compared to non-fluoridation, for all the population sizes considered at analysis. The authors reported that the threshold at which fluoridation was more costly than non-fluoridation occurred for a population between 800 and 900 individuals; smaller populations implied positive costs for the introduction of fluoridation, when compared to non-fluoridation.

The results of the effectiveness analyses showed that fluoridation of the water supply would generate a net cost saving in most of the situations considered.

If the discount rate was 10%, the net cost would be negative for populations with 5,000 individuals or more. Otherwise, every additional averted decayed surface with the fluoridation strategy would cost NZ$32.

In general, costs would increase in direct proportion to the number of injection sites considered, and for populations with 1,000 individuals or less, the use of two to five injection sites would involve spending between NZ$136,000 and NZ$595,000, with cost-effectiveness ratios varying from NZ$92 per averted decayed surface with two sites, to NZ$402 for five sites. Otherwise, fluoridation would be the dominant strategy.

A sub-group analysis focused on the Maori communities showed that the net savings achieved were higher for this sub-group.

Authors’ conclusions
The authors concluded that fluoridation is cost saving for communities of 1,000 people or above. The installation of water fluoridation facilities for presently non-fluoridated supplies remains very cost-effective, particularly for low socioeconomic communities, or those with a high proportion of children.

CRD COMMENTARY - Selection of comparators
The authors chose a ‘doing nothing’ alternative as the comparator. This allowed them to evaluate the actual effect of implementing fluoridation in their setting. You must decide whether this is a valid strategy, or whether there are alternative strategies used to reduce tooth decay in your own setting.

Validity of estimate of measure of effectiveness
The authors did not report that a systematic review had been carried out. They appeared to use data from the available studies selectively. Since the methods used to find and select the primary studies, and to extract data were unclear, it is
difficult to assess the validity of the estimates. There may be relevant studies that were not included and, moreover, not all the assumptions made by the authors were justified with reference to the medical literature. Some assumptions were hypothesised to overestimate effectiveness, while others underestimated it. The authors reported that the effectiveness results may have been biased in an unclear direction. All these facts introduce uncertainty into the effectiveness results.

Validity of estimate of measure of benefit
The authors reported they chose the averted decayed surface as the summary measure of benefit because it was a more sensible measure than averted decayed teeth. The estimated benefits were discounted, although there is controversy in the literature regarding this issue.

Validity of estimate of costs
Although the authors reported that a societal perspective was adopted, no indirect costs were estimated, and no justification was given for this exclusion. The study did not address the likelihood of accidental over-fluoridation in its costs and consequences. Therefore, not all the relevant costs appeared to have been included in the economic analysis. Neither were all the resource quantities reported separately from the costs. Some charges were used, instead of costs, which may reflect the true opportunity cost of the intervention in cases where the patient had to face the dental costs associated with restorations and extractions. There was some confusion regarding the price year finally considered for the cost estimation. Discounting was appropriately performed, although it was not clear why a 10% discount rate was taken into account in the sensitivity analysis. Some biases associated with the cost estimation were reported, which led to an underestimation of the costs related to non-fluoridation, as reported by the authors.

Other issues
The authors stated that their results agreed with those obtained in other studies in relation to lower socioeconomic groups potentially benefiting more than higher socio-economic groups from the fluoridation of water supplies. The results of the analysis were fully reported and the authors’ conclusions reflected the scope of the analysis. The issue of the generalisability of the results was not addressed.

Implications of the study
The authors did not make any recommendations for further research or changes in practice. Lack of available data for adult New Zealanders led the authors to formulate several assumptions about the effectiveness and costs of the fluoridation strategy, which appear to have biased the results, as reported by the authors. Therefore, caution must be taken when interpreting the results of the study.

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Study carried out under contract to the New Zealand Ministry of Health.

Bibliographic details

PubMedID
11357915

Other publications of related interest