Community Preventive Services Task Force

Oral Health: Preventing Dental Caries, Community Water Fluoridation

Task Force Finding and Rationale Statement

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Task Force Finding and Rationale Statement

Intervention Definition

Community water fluoridation (CWF) is the controlled adjustment of fluoride in a public water supply to optimal concentration [www.federalregister.gov/articles/2011/01/13/2011-637/proposed-hhs-recommendation-for-fluoride-concentration-in-drinking-water-for-prevention-of-dental] in order to prevent caries (tooth decay) among members of the community. Fluoride acts to impede demineralization and to enhance the remineralization of dental enamel, both of which prevent dental caries. While fluoride occurs naturally in water across the U.S., it is usually lower than the optimal concentration needed to prevent caries.

Task Force Finding (April 2013)

The Community Preventive Services Task Force recommends community water fluoridation based on strong evidence of effectiveness in reducing dental caries across populations. Evidence shows the prevalence of caries is substantially lower in communities with CWF. In addition, there is no evidence that CWF results in severe dental fluorosis.

Evidence indicates the economic benefit of CWF is greater than the cost. In addition, the benefit-cost ratio increases with the size of the community population.

Rationale

Basis of Finding

The Task Force finding is based on 28 studies about the effect of CWF on caries; 16 about oral health disparities, and 117 about dental fluorosis. Most of these studies were included in an existing systematic review (McDonough 2000, search period 1966-1999; 26 studies on caries; 13 on oral health disparities; 88 on fluorosis), combined with more recent evidence (search period 1999-2012; 2 on caries; 3 on oral health disparities and 29 on fluorosis). Based on this updated review, the previous Task Force finding of strong evidence for this intervention remains the same.

Results from both the McDonough et al. review and the updated search for evidence showed a decrease in new dental caries after community water fluoridation began and an increase in new dental caries when it was stopped. Combined evidence showed a median decrease of 15.2 percentage points in caries after community water fluoridation began (12 studies). Table 1 summarizes results.

Table 1. Summary of Results

Intervention	Measure	Effect Estimates* (McDonagh et al. 2000)	Effect Estimates* (Evidence from 1999-2012)
Fluoride initiation	Percent caries free	Median: 14.6 pct pts (IQI: 5.1 to 22.1 pct pts) 11 studies	Median: 25.1 pct pts (IQI: 20.4 to 30.5 pct pts) 1 study
	Decayed, missing, or filled teeth	Median -2.25 teeth (IQI: -3.63 to -1.28 teeth) 10 studies	-
Fluoride discontinuation	Decayed, missing, or filled teeth	Range: -0.1 to 16 6 studies	-
	Decayed, missing, or filled surfaces	Incidence: Range: -0.2 to 18.8 2 studies	Prevalence: 8 year olds: -0.59 14 year olds: -1.39 Incidence: 8 year olds: +0.13 14 year olds: +0.47 1 study

*Some studies provided results for multiple age groups and reported more than one effect estimate.
IQI, interquartile interval
Pct pts, Percentage points

Applicability and Generalizability Issues

The evidence is considered applicable to the U.S. population, as most of the studies were either from the U.S. or other high-income countries and included fluoride concentrations within 0.7 mg/L and 1.2 mg/L. Included studies provided limited data on other sources of fluoride or race or ethnicity. Thus, the extent to which these factors influenced the effectiveness of CWF could not be evaluated.

Studies that provided data on socioeconomic status (SES) consistently found that CWF is effective for reducing caries across all SES groups. However, there was not enough evidence to clearly determine the effects of community water fluoridation on health disparities between groups. The McDonagh review, plus three studies from the updated search

period, found inconsistent results; disparities in caries decreased in some settings and age groups, but were stable or increased in others.

Data Quality Issues

Quality issues across studies included failure to measure or acknowledge relevant factors such as the contribution of fluoride from other sources or access to dental care. Most of the studies also had measurement issues; many did not blind the examiners, and across studies there was a lack of consistency among indices used to measure caries and fluorosis.

Other Benefits and Harms

Community water fluoridation has the potential to reduce the incidence of caries and save associated costs for future restorative treatment. In addition, people who live in non-fluoridated areas may receive 'halo' benefits when they consume food and beverages processed in fluoridated areas.

The data for fluorosis, both from the existing systematic review and newly identified studies, show a clear dose response relationship with fluoride in drinking water. Fluorosis is an enamel defect ranging in severity from barely noticeable white spots in mild forms to staining and pitting in more severe forms. The critical period for the development of fluorosis is from birth to 8 years. Prevalence of detectable dental fluorosis is around 40% in optimally fluoridated areas. The majority of these cases are mild and difficult to see except by trained dental health professionals, and are not considered to be of aesthetic concern. There is no evidence that CWF results in severe fluorosis.

Although bone fractures and skeletal fluorosis have been associated with lifetime exposure to higher naturally-occurring fluoride concentrations (e.g. 4 mg/L), no association has been observed at levels used for CWF. The broader literature speculates about harms associated with higher levels of fluoride in water (e.g., cancer, lowered intelligence, endocrine dysfunction). Research evidence, however, does not demonstrate that CWF results in any unwanted health effects other than dental fluorosis. While harms have been proposed, most have no biological plausibility or insufficient evidence to draw conclusions.

Economic Evidence

The economic review included 10 studies (search period January 1995-November 2013). Studies were conducted in the U.S. (6 studies), Australia (2 studies), Canada (1 study), and New Zealand (1 study). Evidence included information about the cost and benefit of CWF (6 studies), regression results on changes in healthcare cost, productivity loss, or health claims (4 studies), and cost per disability-adjusted life year (DALY) saved (2 studies). All monetary values are presented in 2013 U.S. dollars.

Intervention cost for CWF has two main components: one-time fixed cost (equipment, pipework, fluoridation pump, and tank area) and annual recurrent cost (fluoride compounds, monitoring, maintenance, and operations). In the included studies, per capita annual cost ranged from $0.11 to $4.89 for urban communities. Population size was the main cause of variation; as the size of a community's population went up, the cost per person went down.

Two types of studies assessed intervention benefits: benefit-only studies that used regression analysis, and cost-benefit studies. Four benefit-only studies that used regression models concluded that the presence of water fluoridation was related to a reduction in dental treatment cost or claims.

Six studies that provided benefit and cost information reported a per capita annual benefit of CWF that ranged from $5.49 to $93.19. In these studies, intervention benefit included one or more of these components: averted health care

cost, averted productivity loss, or other losses averted. Among benefit components, the major drivers were averted restoration and lifetime treatment cost.

Unlike intervention cost, estimated benefit of CWF varied widely. One of the main causes of variation was the number of benefit components considered in each study. Another sources of variation was geographical differences in dental treatment and labor costs.

Benefit-cost ratios ranged from 1.12:1 to 135:1 (six studies). These ratios followed the same pattern as costs with respect to population size, but in the opposite direction. Low benefit–cost ratios generally were associated with small community population sizes, with ratios increasing with community population size. This is mainly related to the economies of scale on the cost side.

Disability-adjusted life year (DALY) averted was used in two studies on cost-effectiveness analysis. For both studies, the cost/DALY averted was well below annual per capita income of Australia (approximately $30,000 in 2013 dollars), which was used as a threshold for cost comparison with DALY averted.

Considerations for Implementation

Overall, the body of evidence indicates that Community Water Fluoridation is an effective intervention for reducing caries at the population level. At optimal fluoride concentration (HHS), associated risks are predominantly the milder forms of fluorosis that are only detectable under clinical examination. Potential barriers to implementation of CWF include start-up costs, social acceptability, media attention, and limited knowledge of the benefits and harms of CWF among the general public, healthcare providers, and policymakers. Where CWF is in place, daily monitoring is recommended to ensure optimal fluoride concentrations are maintained (CDC [www.cdc.gov/mmwr/preview/mmwrhtml/00039178.htm]).

Evidence Gaps

Because all the included studies examined the effectiveness of CWF in children, research on the effectiveness among adults is needed. Standardized reporting techniques and measurements for caries and fluorosis would improve comparability of results across studies.

More research also is needed to understand the following.

- The contribution of fluoride from sources other than water
- The effects of bottled water use (with fluoride naturally present, added, or removed) on caries incidence in fluoridated communities
- Role of water hardness and calcium related to the bioavailability of fluoride among individuals and communities
- Effect of CWF over and above other caries preventive measures, namely dental sealants and fluoride varnishes
- Accumulation of fluoride in calcified tissues (predominantly bone) over time
- Other potential positive or negative health effects
- Actual cost (especially recurrent cost) of CWF interventions, particularly in rural communities with fewer than 1,000 residents
- Cost per quality-adjusted life year (QALY)

The data presented here are preliminary and are subject to change as the systematic review goes through the scientific peer review process.

References

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