The effect of point-of-use water conditioning systems on community fluoridated water

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Abstract

The purpose of this investigation was to determine the effect of several point-of-use water conditioning systems on the fluoride concentration in community fluoridated water. Point-of-use water conditioning systems attach at the sink to provide the user with protection from certain water contaminants. A sampling apparatus was constructed to allow collection of water samples before and after conditioning. The apparatus connected the following types of point-of-use water conditioning systems: a faucet water filter, a cellulose fiber filter, an activated carbon filter, a reverse osmosis system, and a distillation unit. These samples were tested by an independent laboratory using colorimetric determination of fluoride concentration. All point-of-use water conditioning systems tested caused a statistically significant reduction in fluoride ($P < .001$). Of particular note were reductions in fluoride concentration by the activated carbon filter (81%), the reverse osmosis system (84%), and the distillation unit (99%). These reductions are clinically significant, and necessitate supplementation for optimal fluoride intake. Patients using these water conditioning systems should be advised to have their water tested, and to consider fluoride supplementation to ensure adequate benefit from this caries prevention method.

Introduction

Though there is increasing concern about the prevalence of dental fluorosis (Bohaty et al. 1989), community fluoridation remains the most effective means of reducing caries in the general population (McDonald and Avery 1987). Fluoride supplementation is essential for preventing caries in children receiving less than optimal fluoride from their drinking water (Levy 1986). Accurate prescription of fluoride supplements is possible only when the water fluoride concentration is known. Point-of-use water conditioning systems attach at the sink to provide users protection from certain water contaminants (Culligan WaterWatch Information Bureau, publication No. 8193-03, 1987). Information regarding these water conditioning systems indicates they may reduce fluoride "contaminants" in drinking water (Better Business Bureau, publication No. 24-236, 1988).

Point-of-use systems differ from ion-exchange systems, which are plumbed directly to the incoming water line and treat the entire water supply (Culligan WaterWatch Information Bureau, publication No. 8193-03, 1987). The effects of ion-exchange type water softeners on fluoride concentration have been reported previously. The results of these studies were inconsistent. Full and Parkins (1972) reported up to a 40% reduction in fluoride concentration. Groman et al. (1980) reported no significant reduction; however, some of their conditioned samples showed an increase in fluoride. In a follow-up study, Full and Wefel (1983) concurred and reported that this type of water conditioner caused no significant change in fluoride concentration. No reference to point-of-use water conditioning systems was found in the dental literature.

The purpose of this investigation was to determine the effect of several point-of-use water conditioning systems on the fluoride concentration in community fluoridated water.

Materials and Methods

The study consisted of two phases. The first phase was a pilot study to establish procedures and estimate the necessary sample size. Samples were prepared subsequently at approximately 1.0, 0.75, 0.5, and 0.0 ppm (Nikiforuk 1985) by adding sodium fluoride drops (Flura-Drops, NDC 0098–1762–50, 1.0 mg fluoride/0.2 cc—Kirkman Laboratories Inc., Portland, OR) to hospital-grade sterile water (NDC 0338-0002-04, 1000 ml — Travenol Laboratories Inc., Deerfield, IL). A convenience sample of five at each concentration was prepared and submitted for testing. The water samples were tested by the Water Treatment Facility, Fort Lewis, WA, using a colorimeter (Hach Spectrophotometer DR/3000 — Hach Co., Ames, IA) and SPADNS reagent for fluoride (#444, Lot 18BH — Hach Co., Loveland, CO). Samples were collected in polyethylene containers to avoid possible reaction of the fluoride with glass. The samples were submitted randomly in coded containers.

The standard deviation at each concentration was determined. These values were combined to obtain an average sample standard deviation (sigma = 0.05 ppm). To ensure accurate results, a significance level of alpha = 0.005 (conventional alpha = 0.05) and a power of 95% (usual levels of power are 80–90%) were chosen that increased sample size. Based on a minimum change in fluoride concentration of 0.1 ppm, a sample size estimate of 11 was determined using the method described by Rosner (1986). The sensitivity of the testing instrument (± 0.05 ppm) would be more than adequate to determine the change in fluoride concentration that would be clinically significant.

In the second phase, a sampling apparatus was constructed that connected in parallel, according to the manufacturer's instructions, the following types of point-of-use water conditioning systems (All water conditioning systems used were manufactured and distributed by Sears, Roebuck and Co., Chicago, IL, Fig 1):

1. Faucet water filter (#34094) that attaches to the faucet and uses a small, replaceable activated carbon filter
2. Cellulose fiber sediment filter (#3461) in an under sink water filter housing (#3472)
3. Activated carbon filter (#3417) in an under sink water filter housing (#3472)
4. Reverse osmosis under sink filter system filter housing (#3472) that uses a combination of activated carbon filters, sediment filters, and a pressurized reverse osmosis membrane
5. Distillation unit (#3455) that operates by heat distillation of water.

The system was designed to allow collection of water samples before and after conditioning. These samples were submitted for testing as described above.

Results

The results of this study are presented in the table (see next page). Fluoride concentrations were normalized to 1.0 ppm. All point-of-use water conditioning systems tested caused a statistically significant reduction in fluoride. Of particular note were reductions in fluoride concentration (Fig 2, see next page) by the activated carbon filter (81%), the reverse osmosis system (84%), and the distillation unit (99%). The average standard deviation for sample values was 6% (± 0.06 ppm). All *P*-values were $P < 0.001$. Statistical analysis was completed using the paired *t*-test portion of a data analysis program (StatView — Abacus Concepts Inc., Berkeley, CA).

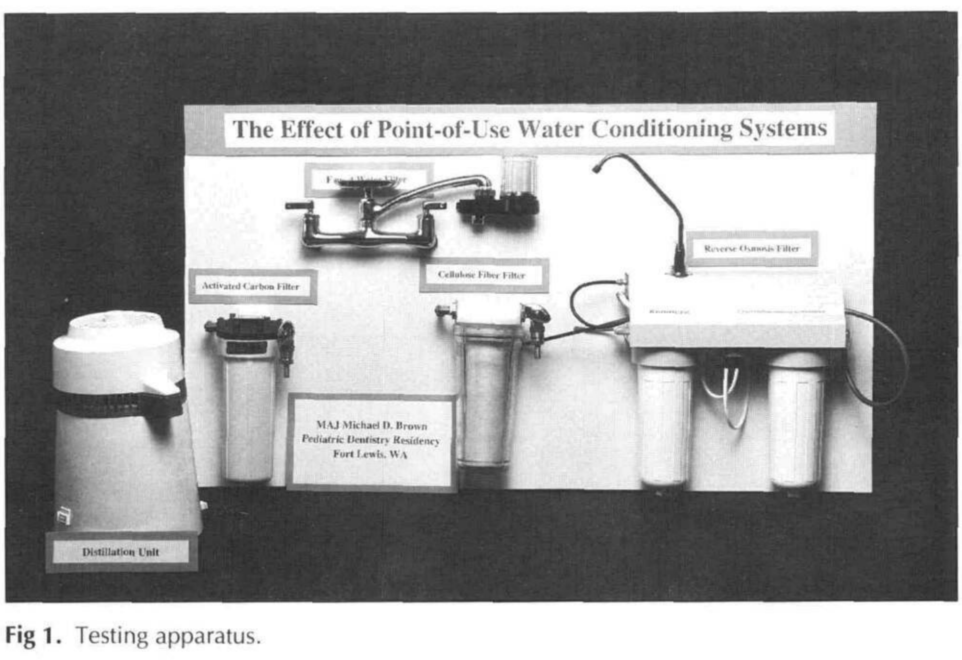

Fig 1. Testing apparatus.

Table. Fluoride Reduction by Point-of-Use Water Conditioning Systems

	Actual Fluoride Reduction (ppm)	*Normalized Fluoride Reduction (ppm)*	*Paired t-test (vs Control)*
	Mean ± SD	*Mean ± SD**	*P Value*
Faucet Filter	0.14 ± 0.091	0.13 ± 0.088	0.0004
Cellulose Filter	0.15 ± 0.079	0.13 ± 0.067	0.0002
Activated Carbon Filter	0.88 ± 0.115	0.81 ± 0.094	0.0001
Reverse Osmosis System	0.91 ± 0.098	0.84 ± 0.056	0.0001
Distillation Unit	1.08 ± 0.082	0.99 ± 0.019	0.0001

N = 11 for each filter
* Mean normalized to 1.0 ppm

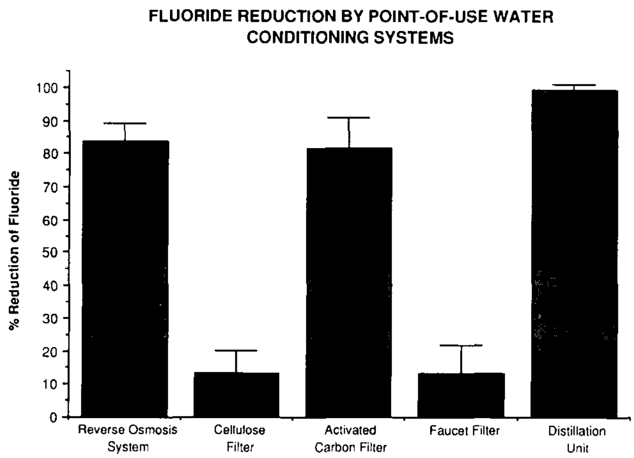

Fig 2. Graph illustrating reductions in fluoride concentration.

Discussion

The results of this study indicate that point-of-use water conditioning systems can reduce substantially the amount of fluoride present in drinking water in a fluoridated community. Though statistically significant reductions were noted for all water conditioning systems tested; the activated carbon filter, the reverse osmosis system, and the distillation unit produced clinically significant fluoride reductions. According to American Dental Association (ADA) guidelines, children receiving water fluoridated at less than 0.7 ppm should receive fluoride supplements (ADA 1983). Children living in homes where the water is treated by one of these point-of-use water conditioning systems may require fluoride supplements, even in areas where the water is fluoridated optimally.

Earlier reports have questioned the use of colorimeters to determine fluoride content (Brossok 1987; Weinberger 1989). The low sample standard deviations in the pilot study (mean sample standard deviation = 0.05 ppm) and phase two (mean sample standard deviation = 0.06 ppm) indicate that careful use of this method of analysis allows accurate determination of fluoride concentration changes. The colorimetric method has the advantage of being less expensive and easier to operate than current electrode methods, and may allow dentists to determine the fluoride content of their patients' water in the office.

The water treatment industry currently has about 400 manufacturers with sales expected to top $1 billion by 1995 (Consumer Reports 1990). Health care professionals should be aware that even patients living in fluoridated areas may not be receiving adequate fluoride. Some point-of-use water conditioning systems reduce the fluoride content, resulting in the need for fluoride supplementation. Accurate prescription of fluoride supplements depends on accurate determination of the fluoride concentration in patients' drinking water. Patients in fluoridated areas should be questioned about their use of home water conditioning systems. Their water should be tested to ensure that they are receiving optimal amounts of fluoride.

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Teen suicide prevention programs may miss the mark

Many teen suicide prevention programs may not be reaching at-risk youths, according to a study published in the *Journal of the American Medical Association.*

The study evaluated the impact of school-based suicide-prevention programs on a group of 973 adolescents, 63 of whom indicated on two occasions that they had made a suicide attempt. The students were divided into two groups: 524 were exposed to the program (35 of whom said they had attempted suicide), and 449 were not exposed (28 of whom reported attempting suicide).

Of the 524 exposed to the program, the attempters' reactions to the programs were generally more negative than those of the nonattempters," according to the report by David Shaffer, FRCP, FRC Psych, director of the Division of Child and Adolescent Psychiatry, Columbia University College of Physicians and Surgeons, New York, NY, and colleagues. Attempters exposed to programs were significantly less likely to recommend that the programs be presented to other students, and were significantly more likely to indicate that talking in the classroom about suicide makes some students more likely to try to kill themselves.

In assessing the impact of the program, the authors compared the 35 attempters who were exposed to the program to the 28 attempters who were not. They found that exposure to the program did not significantly influence attempters' attitudes about suicide.

In an accompanying editorial, Susan J. Blumenthal, MD, MPA, chief, Behavioral Medicine Research Program, National Institutes of Mental Health, Rockville, MD, wrote: "Results from this study and from other research evaluating this type of preventive intervention suggest that it is extremely difficult and very expensive to predict which youth in the general population will kill themselves, given that adolescent suicide is a rate event with low specificity (high false-positive rates). Since there is currently slender systematic evidence to either support or refute the efficacy of most types of suicide prevention and intervention programs, we can conclude that interventions aimed at the general population will be of the lowest utility, whereas programs targeted at treated or untreated high-risk youth would be the most beneficial. The study by Shaffer and colleagues represents an important contribution to our understanding of the limitations of some types of suicide education programs and points us in new directions for future research aimed at the identification of young people at high risk for suicidal behavior."