

Acute Fluoride Poisoning Associated with an On-Site Fluoridator in a Vermont Elementary School

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Abstract: On August 30, 1980, an outbreak of minor illnesses consisting of nausea and vomiting affected 22 individuals attending a farmers market at a school. Illness was associated with the consumption of beverages made from school water ($X_c^2 = 65.6$, $p < .0001$); analysis of the water showed high levels of fluoride (1,041 mg/l). The most likely source of the contamination was the school fluoridator, which had accidentally been left on continuous operation. (*Am J Public Health* 1982; 72:1168-1171.)

Introduction

On Saturday afternoon, August 30, 1980, the principal of a small elementary school called the Vermont State Department of Health to report an outbreak of gastrointestinal illness. The outbreak had occurred just before the opening of a farmers market held in the school parking lot and primarily affected vendors and their families. The school participates in an on-site water fluoridation program for the prevention of dental caries in the school population. The water supply for the school is from a community water system, which is not fluoridated. It appeared that those who had become ill drank several beverages prepared with water obtained from the school; therefore, fluoride poisoning was suspected. The Vermont State Department of Health conducted an epidemiologic and environmental investigation to determine the cause and the extent of the outbreak.

Methods

Vendors and their family members who attended the market were queried for information about their illness and the type and amount of beverage and food consumed. An inspection of the school water system was done, and 1-liter samples of the water from the school system were obtained on the day of the outbreak and again two days later. These

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water samples were evaluated for fluoride concentration using colorimetric analysis with an automated distillation procedure as described by Long and Stowe.¹

Results

Of the 44 vendors who attended the farmers market, 40 (91 per cent) were contacted. Inclusion of their family members brought the total subjects to 82; of these, 22 (27 per cent) reported a characteristic illness on the day of the market. All had onset of symptoms between 8:30 and 10:30 am. Of those ill, nausea was reported by 16 and vomiting by 13. Other symptoms included headache (5), cramps (4), dizziness (3), and diarrhea (2). Duration of the illness ranged from 1-24 hours. The age range of the ill persons was 9-70 years with a median of 36 years. None of the ill individuals saw a physician.

Illness was strongly associated with drinking beverages made from school water ($X_c^2 = 65.6$, $p < .0001$). Twenty (91 per cent) of the respondents who drank these beverages became ill compared to a lack of illness among all who refrained. All ill individuals had onsets of symptoms within 30 minutes of drinking these beverages. Illness was only associated with beverages made with school water.

Of the 17 people who drank coffee made with the school water, nine reported a strange taste (metallic or salty), but none reported a strange smell.

A level of 1,041 mg of fluoride/liter was detected in a 1-liter water sample that a vendor had drawn from the system the morning of the outbreak. After the system was flushed out two days later, the fluoride concentration dropped to 0.7 mg/liter.

The school had two on-site fluoridation units, each unit consisting of a chemical metering pump with an anti-siphon valve on the discharge, and using a pacing system for the fluoride solution feed. The fluoride injection point into the water system is downstream from the meter, and neither unit has a flow switch (Figure 1).

Both solution feed pumps have a three-position switch (manual-off-automatic). The switch on the solution feed pump serving the water which had a high fluoride concentration is not spring-loaded and could be left in the manual position.

Environmental inspection of the fluoridation system after the outbreak found no evidence of mechanical failure. These fluoridation units were last serviced three days before the farmers' market was held. At this time, both fluoride solution feed units were filled with a 2 per cent solution of

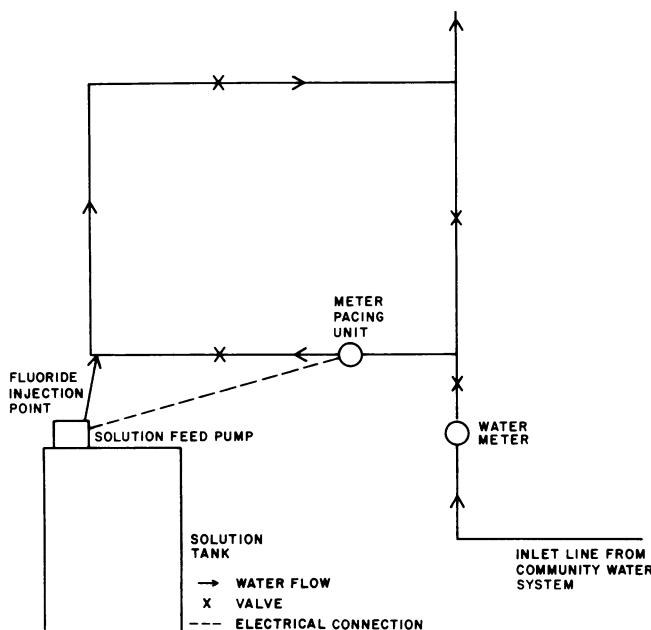


FIGURE 1—School Fluoridation Unit, Vermont, 1980

sodium fluoride. The suspect unit was probably left in the manual mode after servicing. In this mode, it fed fluoride continuously into the school water system. Approximately 17 more liters of fluoride solution had been injected into the water system from this fluoride unit compared to the other unit at the school. Since school was not yet in session, there was little water demand or flow prior to the farmers market and a high concentration of fluoride developed in the system. The level of 1,041 mg of fluoride/liter that was identified on the day of the outbreak was over 150 times the recommended fluoride concentration used in school water systems for the prevention of dental caries. If the community water system has no fluoride, school water systems are recommended to have 4.5 times the National Interim Primary Drinking Water Standard of 0.7 to 1.2 mg/L of fluoride.^{2,3}

Because the fluoride concentration of the water was known and the quantity of the beverages consumed was obtained on the questionnaire, the amount of fluoride ingested by each ill individual could be estimated. Seven individuals reported nausea alone as a symptom. They had a mean estimated fluoride consumption of 80 mg with a range of 47–94 mg. Thirteen individuals had vomiting, with a mean estimated fluoride consumption of 143 mg, range 94–188 mg. No correlation was found between the amount of liquid consumed and a more abrupt onset or longer duration of illness.

Discussion

This is the fifth reported outbreak in the United States of acute fluoride poisoning associated with drinking water. Two of the previous outbreaks occurred from a contaminated school water system^{4,5} and two occurred from a contaminated municipal water system.^{6,7} In all but one of the

previous outbreaks, the high concentration of fluoride resulted from an electrical or mechanical malfunction of the system. One previous outbreak was caused by operator error. The Vermont outbreak was caused by operator error and poorly designed equipment. The fluoridation system was not designed to prevent accidental accumulation of fluoride in the system when the feeder was in the manual mode.

The ingestion of a concentrated solution of fluoride causes gastric irritation and may cause salivation, abdominal pain, nausea, vomiting, and diarrhea. The concentrations of fluoride that produced nausea and vomiting in this outbreak were slightly higher than those reported by Theines.⁸ He estimated that as little as 7 mg of fluoride could produce nausea, and 29 mg could produce vomiting. Higher levels of fluoride ingestion would be expected to cause other symptoms such as muscle twitching, cardiac arrhythmias, convulsions, and shock; none of these symptoms were apparent in this outbreak. The lethal dose of fluoride in acute accidental ingestion is 2.5–5.0 grams in a 70 kg man.⁹

To prevent future outbreaks of acute fluoride poisoning in this school and other Vermont schools, we recommended that all fluoride equipment be equipped with spring-loaded switches to prevent them from being left in the manual position. In addition, interlock flow switches should be installed so sodium fluoride could only be added when there was a demand for water.

The safety of fluoridation is evidenced by the rarity of acute fluoride intoxication despite relative widespread use. The benefits of fluoridation for the prevention of dental caries far outweigh the illness produced by rare mechanical failures of fluoridation equipment. However, public health officials are obligated to minimize the possibilities of excess exposure by inspecting systems regularly and installing equipment that can protect against the consumption of high concentrations of fluoride.

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