Case 18

Preventing Dental Caries in Jamaica

Geographic area: Jamaica

Health condition: In the early 1980s, dental caries in Jamaica was widespread. On average, children had 6.7 decayed, missing, or filled teeth, and fewer than 3 in every 100 children were free of caries.

Global importance of health condition today: Dental caries, or tooth decay, is one of the most common chronic health problems of children. Untreated caries is painful and may affect diet, school attendance, and sleep. Tooth decay can have significant negative health and social consequences in later life.

Intervention or program: In 1987, at the encouragement of a dentist from the country's Ministry of Health, Jamaica's only salt producer began producing and selling fluoridated salt. The Ministry of Health and the Jamaican Parliament completed the necessary legal and regulatory framework, and the government provided biological and chemical monitoring of the salt.

Cost and cost-effectiveness: Salt fluoridation costs only 6 cents per person annually. Cost savings from the program are extraordinary: For each $1 spent on salt fluoridation, $250 will be saved in reducing the need for future dental treatment.

Impact: By 1995, the health of children's teeth in Jamaica had improved dramatically. In both 6-year-olds and 12-year-olds, the index of the severity of caries had fallen by more than 80 percent.

Some public health programs attract wide financial and political support because the health conditions they address are seen as severe, even life-threatening. Others are out of the public view because they tackle smaller problems, albeit concerns that may profoundly affect quality of life. Donors rarely line up to fund such programs, and politicians make little effort to lead the charge. However, such modest initiatives—exemplified by Jamaica's successful effort to reduce the incidence and severity of dental problems among children—can demonstrate how small amounts of money, applied intelligently, can quietly and steadily raise the health status of populations.

The first draft of this case was prepared by Phyllida Brown.

Problem of Dental Caries

Dental caries is the progressive loss of tooth mineral and the invasion of the demineralized tooth by bacteria. It develops when bacteria stick to the surface of the tooth, forming plaque. When a person eats food containing simple sugars, the bacteria use the sugars for their own metabolic needs and produce acids as by-products.

Caries is common among children worldwide, and, though declining, remains a persistent problem in many regions.[1] Poor oral health can add significantly to the disadvantages a child faces, in terms of both personal health and life chances. Untreated caries is painful and may affect diet, school attendance, and sleep. Unresolved oral health problems can affect a child's

speech and language, as well as appearance, self-image, and even social functioning.

Poor oral health can be lifelong and span many generations. Impaired eating habits and persistent oral infections can continue into adulthood and contribute to overall health. Biomedical and epidemiologic research has found that pregnant women with long-standing gum disease significantly increase their risk of having a premature birth and other adverse outcomes. In fact, one study found that pregnant women with periodontal disease are seven times more likely to deliver a preterm or low birth weight baby, controlling for other factors.[2] In short, although dental caries rarely makes it to the top of the health priority list, it merits attention as an important determinant of both child and adult health.

In many populations, a disadvantaged minority of children suffer a much higher burden of caries than their more affluent peers and also are less likely to have received treatment. In the United States, for example, almost 37 percent of children aged 2 to 9 years living below the poverty level have at least one untreated carious tooth, compared with 17.3 percent of nonpoor children in this age group. A similar pattern is evident in other countries.[1]

Prevention of Dental Caries with Fluoride

Dental treatment is expensive, and the costs of treating caries mount with the progression of the disease. In many developing countries, treatment is unavailable because of a shortage of dentists.[1] It is in such settings where prevention can make the biggest difference.

Since the mid-20th century, researchers have known that much dental caries can be prevented. In countries and areas where fluoridated water, toothpaste, or salt has been made available, the prevalence of caries has fallen sharply, despite the fact that people continue to consume large amounts of sugar.

In 1945, the town of Grand Rapids, Michigan, became the first to deliberately add fluoride to its water. The levels of caries in the town's children were then compared over a period of years with those of children in a "control" town, Muskegon, where water was not fluoridated. In Grand Rapids, dental caries declined significantly. Several other studies in other cities followed, each showing similar results. In a review of 95 studies conducted between 1945 and 1978,[3] Murray et al reported that water fluoridation reduced caries by around 40 to 50 percent in primary teeth and 50 to 60 percent in permanent teeth.[4] Since that time, parts of the developing world in which dental caries poses a serious problem for both children and adults have sought to adapt the approach of fluoridation to local circumstances.

Jamaica's Intervention Takes Shape

In the early 1980s, Dr. Rosalie Warpeha, a Catholic nun trained as a dentist who had lived for many years in Jamaica and worked with the Jamaican Ministry of Health, surveyed Jamaican children's teeth and found that severe caries was widespread. By age 12, fewer than 3 in every 100 children were free of caries, and on average children had 6.7 decayed, missing, or filled teeth.[5] Characterized by an inquiring mind and dogged commitment to finding solutions to vexing problems, Warpeha sought ways to introduce fluoridation to reduce the prevalence of this problem; she identified salt, rather than water, as the vehicle. Regulated water distribution systems are largely unavailable outside the capital, Kingston, and many people use rainwater.[6]

Jamaica's circumstances were highly favorable for introducing fluoridated salt, says Dr. Saskia Estupiñán-Day, regional adviser on oral health for the Pan American Health Organization (PAHO). All of the island's water supply naturally contains very low levels of fluoride, so fluoridated salt could be used everywhere. Equally important, the island has one sole salt producer, Alkali Limited, so the intervention could be achieved fairly simply.

In 1984, Warpeha visited Alkali Limited. Trevor Milner, a chemical engineer there, was interested in what she had to say. "She sold us the idea of salt fluoridation," he says. Warpeha also told Milner and his colleagues the results of Colombian community trials (see Box 18–1). She knew that Alkali Limited already iodized its salt. "Why not add fluoride too?" she asked. "We said, yes, this looks like something we could do," says Milner.

Box 18–1
Water or Salt?

Water fluoridation is effective only if the water supply system is regulated and the majority of inhabitants have access to the piped water system. In the 1960s and early 1970s, a community trial of salt fluoridation was conducted in Colombia, supported by PAHO and the US National Institutes of Health. Two communities receiving fluoridated salt—fluoridated at the rate of 200 mg of fluoride per kilogram—experienced reductions of nearly 50 percent in dental caries, compared with no reduction in a third community that served as a control, and compared with a 60 percent reduction in a fourth community that received fluoridated water.[7] Thus, while slightly less efficient than water fluoridation, salt fluoridation was shown to be highly beneficial.

There were questions to answer first, however, says Milner. Which fluoride chemical should be used? At what levels? Would the fluoride interact with other compounds in the salt? For answers, Milner and other chemical engineers from salt manufacturers in Latin America and the Caribbean traveled to Switzerland, with support from PAHO, to learn about salt fluoridation. After this visit, Alkali Limited installed the necessary equipment at a cost of about $3,000, which the company recovered with a slight increase in the price of salt. In 1985 and 1986 the Ministry of Health and the Jamaican Parliament completed the necessary legal and regulatory framework for salt fluoridation. A major advertising campaign informed Jamaicans of the fluoridation program, and in 1987, fluoridated salt went on sale. The salt contained 250 mg per kilogram of potassium fluoride, a concentration used for domestic salt in Switzerland and France.

The Ministry of Health provided biological and chemical monitoring of the salt, while the company performed its own quality control tests daily. The Jamaican Bureau of Standards monitored the fluoride concentration of the salt.

Major Improvements in Oral Health

In 1995, Warpeha and Estupiñán-Day and their colleagues again surveyed children's teeth. They found a dramatic improvement. The index of the severity of caries had fallen by more than 80 percent in both 6 and 12-year-olds.[8] The risks appeared to be minimal: fewer than 1 percent of children examined showed any evidence of excess exposure to fluoride, and even in these cases the problem was mild.

These striking results delighted the researchers. "We were surprised and very happy," says Estupiñán-Day. "It was almost too good to be true." Independent scientists confirmed the findings and, in a separate line of evidence, the island's dentists reported that the incidence of dental caries was rapidly diminishing.

Are There Other Explanations?

Because the introduction of fluoridated salt in Jamaica was a national-level community intervention, it is impossible to be certain that the fluoridated salt alone achieved the reduction in dental caries. Communities elsewhere in the world without access to fluoridated water or salt have also seen some modest reduction in dental caries in recent decades, usually attributed to the introduction of fluoride-containing toothpastes.[4] In Jamaica, fluoridated toothpaste had been available for 12 years before the 1984 survey and may have already reduced caries levels somewhat by that date. However, in the absence of data on the proportion of children using fluoride toothpastes in 1984 or 1995, it is impossible to judge what part these toothpastes may have played in improving children's teeth during the decade. During the 1980s and early 1990s children in Jamaica rarely had access to dental health education in school, and school dental services were very limited. (See Box 18–2 for information about a new, lower-cost approach to treatment.) Estupiñán-Day and her colleagues concluded that although a combination of factors may have been

Box 18-2

Filling the Gap

Even with salt fluoridation, some children will get cavities. Once they do, the integrity of the teeth must be restored quickly and well to avoid extensive damage, as well as the pain and poor nutrition that go along with erosion of teeth. The traditional approach, for those with access to dental care, is to have the cavities filled with amalgam, using electric drilling equipment. While this type of restoration can be very functional and long lasting, it is also relatively costly and often unavailable to low-income populations.

Recognizing this gap, PAHO's oral health team sought an alternative. Exploring ways to expand access, Estupiñán-Day and colleagues saw promise in simple technologies known as atraumatic restorative treatment (ART), which uses hand instruments and inexpensive adhesive filling. Clinical studies in the early 1990s suggested that ART could give good results, but questions existed about its cost-effectiveness and large-scale implementation under field conditions.

In a recent study involving more than 2,000 children in three countries (Ecuador, Panama, and Uruguay), and with support of the Inter-American Development Bank, PAHO and its research collaborators compared three different approaches: Traditional fillings using amalgam, applied by a qualified dentist; ART, applied by a qualified dentist after undergoing 40 hours of training; and ART, applied by a dental auxiliary with 40 hours of training. Children were randomly assigned to one of the three treatments, and then followed up at intervals of 12, 24, and 36 months.

The results, published in 2006, were very encouraging. Across a range of real-world conditions, the restoration of teeth using ART was excellent—precisely as good as the restoration using amalgam, and equally satisfactory whether performed by a dentist or an auxiliary. Even at the two-year mark, ART restorations held up very well.

Importantly, the costs were much lower. In Ecuador, for example, the average cost for an amalgam procedure was $7.77, while for an ART procedure it was $3.64 or $1.48, depending on whether a dentist or auxiliary performed the service. In Uruguay, the differential was even larger: it cost an average of $33.64 for a dentist to restore a tooth with amalgam, and only one tenth that amount for an auxiliary to use ART for the same purpose—with both types of treatment achieving excellent results.

This important study paves the way for widespread adoption of ART in government health services, particularly in low-income communities where dental services are scarce. It represents one more step toward improved oral health in the region of the Americas.

responsible for the improvement in children's teeth, salt fluoridation is "the likeliest factor."

The program has continued to be implemented successfully since 1995, thanks in part to passage of legislation to protect the fluoridation program; fluoridated salt is also being exported from Jamaica to neighboring countries. (Warpeha continued to conduct research about dental health in Jamaica up until the time of her death in 2006.)

Cost-Effectiveness of Salt Fluoridation

The cost of the chemicals is low, at about 1 cent per person per year. Taking into account the entire cost of the fluoridation program, including equipment, run-

ning costs, and monitoring, salt fluoridation in Jamaica costs around 6 cents per person annually. This is an even lower cost than water fluoridation, which may cost up to 90 cents per person per year, depending on the size of the community.[4]

In treatment costs alone, the return on investment in salt fluoridation is substantial, leaving aside any less easily measured benefits such as reduced absence from school or improved health in later life. It is estimated that for each $1 spent on salt fluoridation in Latin America and the Caribbean, about $250 will be saved in reducing the need for future dental treatment.[8] "This makes fluoridation of salt one of the most cost-effective interventions known to modern public health," says Estupiñán-Day.

A Lasting Legacy

Through its impact on the health and well-being of children from low-income households, and the demonstration effect that influenced other countries in the region, the Jamaican salt fluoridation program shows how much can be achieved with focused attention and creative problem solving.

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