International Perspectives and Practical Applications on Fluorides and Fluoridation

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In 1994 the Pan American Health Organization's Regional Office of the World Health Organization (WHO) drafted an initial strategy to implement caries prevention programs in the region of the Americas utilizing both water and salt fluoridation. The strategy emphasizes caries prevention by ensuring that any fluoride deficiency in the population of the region is compensated by the ingestion of fluoride either through the traditional means of water or salt. It was PAHO's intention along with more than 38 member governments to pursue national programs of salt and water fluoridation for the majority of the member countries in the region (1). The regional strategy called for feasibility assessments, measurement of oral health status, development of fluoride surveillance systems, assessment of the salt industry's capacity to fluoridate salt, cost-benefit studies, and follow-up evaluations.

PAHO's technical cooperation with the countries was possible thanks to the involvement of recognized scientists such as Dr. Herschel S. Horowitz. He played such an important role in the improvement of oral health in the region of the Americas that, because of him, millions of people have better oral health in more than 37 countries in Latin America and the Caribbean. He was involved in the regional plan from the early stages with his knowledge about caries prevention and fluorides, and dental public health. The expertise in caries prevention and fluorides was of added value to the overall regional strategy. He was a great public health scientist, easy to talk to, and humble. He was so good to PAHO, and encouraged the program in launching an aggressive plan to introduce salt fluoridation in almost every country of the Latin America and the Caribbean region. There were no half-hearted approaches for Herschel. The launching of the regional plan was ambitious, and he gave it confidence thanks to his impeccable scientific analysis.

From 1993 to 2000, Herschel Horowitz traveled on behalf of PAHO to Mexico, Costa Rica, Jamaica, Ecuador, Argentina, Uruguay, New York, Colombia, Venezuela, and Nicaragua. He was PAHO's gold standard scientist on fluorides. His proactive approach to fluoride policy was firmly based on scientific knowledge and he realized that PAHO had a great opportunity to implement fluoridation programs and move forward the agenda for almost every country in the Americas. His conviction was that oral health could be improved with fluorides. His contributions were various: methods for measuring fluoride, guidelines for surveillance and the biological and chemical monitoring of fluorides, fluorosis surveys and assessments and survey designs and calibration, fluoride assessments, range of fluoride in salt, and evaluation.

Multiyear Plan for Water and Salt Fluoridation for the Americas

The importance of disease prevention was the cornerstone of PAHO's oral health policy for the region of the Americas. The policy, as outlined in PAHO's Regional Oral Health Plan, emphasizes oral diseases prevention by ensuring comprehensive oral health programs and pursuing sustainable oral health interventions for the majority of the 38 member states. The most recent data on oral health indicate a wide range of oral health conditions. For example, dental caries affects 90 percent of school-aged children and is the most prevalent disease in the Americas. DMFT (the mean number of decayed, missing, or filled teeth) at age 12 years ranges from 0.63 to 6.0.

The fluoridation plan launched by PAHO called for the measurement of the baseline oral health status. Over the interval of the last 12 years, PAHO has assisted most countries in carrying out DMFT surveys. Table 1 presents the most recent data on DMFT (2) for the various countries of the region.

Fluoridation programs using salt as a vehicle are already in place in Bolivia, Colombia, Cuba, Dominican Republic, Ecuador, El Salvador, Honduras, Nicaragua, Venezuela, Costa Rica, Jamaica, Mexico, Peru, and Uruguay. Projected programs are for Bahamas, Haiti, Guyana, and Suriname. Water fluoridation systems continue to expand in Argentina, Chile, and Puerto Rico. Already established water fluoridation programs are reaching more than 65 percent of the population in the United States, 40 percent in Canada, and more than 80 percent in São Paulo, Brazil.

Altogether, over 350 million individuals have access to fluoridation programs in the Americas. It is projected that more than 430 million individuals will have access to fluoridation programs by the year 2010.

For the overall fluoridation plan, comprehensive oral health programs were developed and implemented throughout the region. Although tailored to the specifics of each country adopting such plans, the major components include the following steps:

- country baseline studies to assess oral diseases, DMFT, and exposure to fluoride;
- cost-benefit analysis of various interventions;
- epidemiologic surveillance systems for fluoridation, including biological and chemical monitoring of all fluorides, and quality control of fluoride supplementation;
- salt industry assessments, where appropriate;
- evaluation and tracking systems to determine effectiveness of national

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TABLE 1
Dental Caries Data for the Region of the Americas

Country	DMFT-12
Anguilla	2.5 (91)
Argentina	3.44 (87)
Aruba	2.9 (90)
Bahamas	1.3 (00)
Barbados	0.84 (01)
Belize	0.63 (99)
Bermuda	0.2 (89)
Bolivia	4.67 (95)
Brazil	2.78 (03)
Brazil, São Paolo	1.75 (03)
Canada	2.1 (97)
Chile	3.42 (99)
Colombia	2.30 (98)
Costa Rica	2.46 (99)
Cuba	1.62 (98)
Curacao	0.80 (01)
Cayman Islands	0.9 (99)
Dominica	2.0 (95)
Dominican Republic	4.31 (98)
Ecuador	2.95 (96)
El Salvador	1.36 (00)
Grenada	2.70 (00)
Guatemala	5.18 (02)
Guyana	1.33 (95)
Haiti	1.00 (00)
Honduras	4.00 (98)
Jamaica	1.1 (95)
Mexico	2.00 (01)
Nicaragua	2.8 (97)
Panama	3.61 (97)
Paraguay	3.83 (99)
Peru	2.9 (96)
St. Lucia	6.0 (04)
Suriname	1.9 (02)
Trinidad and Tobago	0.6 (04)
Turk and Ciacos	0.92 (02)
Uruguay	2.50 (99)
USA	1.7 (00)
Venezuela	2.12 (97)

Source: PAHO Regional Oral Health Program 6/04.

TABLE 2
Dental Caries in Countries with Consolidated National Salt Fluoridation Programs

	Baseline Studies		Follow-up Studies		
Country	Year	DMFT-12	Year	DMFT-12	Caries Reduction (%)
Colombia	1980	4.8	1998	2.3	52.1
Costa Rica	1988	8.4	1999	2.5	70.6
Jamaica	1984	6.7	1995	1.1	83.9
Mexico	1987	4.6	1996	2.5	45.7
Uruguay	1982	4.1	1999	2.4	41.5

Source: PAHO, 2004.

TABLE 3
Cost-benefit Calculations for Selected Countries

Country	Program Cost US$ (000)	Caries Prevented (000)	Cost-benefit Ratio
Belize	187	115	1:126
Bolivia	785	10,650	1:136
Dominican Republic	520	12,500	1:203
Honduras	527	8,340	1:122
Panama	424	4,133	1:146
Paraguay	360	5,303	1:123
Total	2,803	41,041	

Source: Reference 4.

fluoridation programs; and

- country legislation and legal enforcement of fluoridation programs.

PAHO's technical cooperation was centered on providing technical expertise to countries to guide and carry out these program components. Taking a team approach, PAHO assembled various consultants who specialized in a particular component of the program. Local expertise in each country was identified and developed such that each country or subregion would become self-sufficient.

Concrete results of the fluoridation plan included: 37 national oral health surveys, assessments and visits to 30 countries, and over 130 producers/processors of salt, and development and adoption of legislation and regulation on the use of fluorides in various countries.

The experience with salt fluoridation shows that it is as effective in preventing caries as water fluoridation. Data collected from the various national programs are showing high rates of prevention of caries. Despite potential methodologic differences in the implementation of salt fluoridation programs as well as in the assessment of effectiveness outcomes, it is clear that salt fluoridation has achieved dramatic preventive results. Selected data collected in the Americas corroborate those findings. Table 2 summarizes data related to the effectiveness of salt fluoridation. Effectiveness, in this context, is assessed by the reduction in caries between baseline and follow-up observations.

For example, in Jamaica, caries was reduced by 83 percent after eight years of program implementation. In 1987, a comprehensive salt fluoridation program was initiated. In 1995, a survey of Jamaican children was conducted to assess the effectiveness and risk of salt fluoridation. Dental examinations of 1,200 children ages 6 to 8, 12, and 15 years showed a mean DMFT prevalence for 12-year-olds of 1.08, compared with the corresponding score of 6.7 DMFT for children of the same age at the baseline examinations in 1984. The percentage of sound permanent teeth in all age groups was 95 percent (3).

The economics of salt fluoridation in the Americas is beginning to be understood. As more experience with the programs is accrued across countries, more information on this matter will become available. In any case, it is possible to indicate here that production costs of fluoridated salt are generally modest. In Switzerland, for example,

production costs are between $0.2–$.04 per kilogram of salt to serve approximately 6 million people. In the Americas, most completed studies have to do with the economic feasibility of programs using estimated costs.

Cost-benefit analyses conducted by PAHO in various countries use very conservative assumptions: dental service coverage to approximately 50 percent of the population at an average of $10 per dental visit. A summary of results of these studies is shown in Table 3.

Estimates reveal that the cost-benefit ratio ranges from 1:122 to 1:203. This means that in the case of Bolivia at a cost-benefit ratio of 1:136, for every dollar invested in salt fluoridation programs, the country will save $136 dollars in curative dental care that is avoided. Salt fluoridation is proving to be one of the most effective interventions in modern public health.

Oral Health Status Development Continuum

When the fluoridation plan was developed, a regional framework was proposed that will allow for recognition of individual country problems and develop targeted strategies. The first step adopted on the plan was a country classification. A first approximation, based on available data and a framework, indicated that DMFT-12 was the most important factor in grouping counties along an oral health development continuum. The DMFT-12 index was used extensively in the region and three stages of oral health development were defined: first, *emerging*, defined as DMFT-12 greater than 5; second, *growth*, defined by a DMFT-12 of 3 to 5; and third, *consolidation*, defined by a DMFT-12 lower than 3. Based on this criterion, Tables 4, 5, and 6 group countries along an oral health status development continuum.

The overall oral health strategy drafted in 1994 drove countries along the development continuum, from the emerging category to the consolidation category. In other words, PAHO's strategy developed a series of activities and provided technical cooperation to the countries aimed at moving from high levels of disease and lacking appropriate preventive policies toward achieving improved status indicators and policies.

Building Strategic Alliances and the Role of Scientists

There is no doubt that Herschel Horowitz made a difference in the implementation of fluoridation programs in the Americas. Without his leadership, the generally positive response to fluorides may have been very different. His influence and prestige at the time was crucial. Without it, many persons in Latin America would not have been so readily convinced that the technical efficacy of fluoridated salt was equal to fluoridated water and that the use of salt in the Latin American setting was better from a cost-effectiveness perspective. Herschel was a brilliant, committed colleague who during the last 10 years was the most significant consultant to PAHO's oral health programs. He gave unhesitating support and commitment to public health dentists in the Americas in the implementation of salt fluoridation programs in Latin America and the Caribbean.

TABLE 4
Typology Before 1990

Emergent DMFT>5	Growth DMFT 3–5	Consolidation DMFT<3
Belize	Argentina	Bahamas
Bolivia	Canada	Bermuda
Brazil	Colombia	Cuba
Chile	Ecuador	Guyana
Costa Rica	Cayman Islands	Dominica
Dominican Republic	Mexico	USA
El Salvador	Panama	
Guatemala	Peru	
Haiti	Trinidad/Tobago	
Honduras	Venezuela	
Jamaica		
Nicaragua		
Paraguay		
Uruguay		

Source: PAHO, 2004.

TABLE 5
Typology Circa 1996

Emergent DMFT>5	Growth DMFT 3–5	Consolidation DMFT<3
Belize	Argentina	Bahamas
Dominican Republic	Brazil	Bermuda
El Salvador	Bolivia	Canada
Guatemala	Chile	Cuba
Haiti	Colombia	Guyana
Honduras	Costa Rica	Jamaica
Nicaragua	Ecuador	Dominica
Paraguay	Mexico	USA
Peru	Panama	
	Puerto Rico	
	Suriname	
	Trinidad/Tobago	
	Uruguay	
	Venezuela	

Source: PAHO, 2004.

TABLE 6
Typology Circa 2004

Emergent DMFT>5	Growth DMFT 3–5	Consolidation DMFT<3
Guatemala	Argentina	Anguila
St. Lucia	Bolivia	Aruba
	Chile	Bahamas
	Dominican Republic	Barbados
	Honduras	Belize
	Panama	Bermuda
	Paraguay	Brazil
		Canada
		Cayman Islands
		Colombia
		Costa Rica
		Cuba
		Curacao
		Dominica
		Ecuador
		El Salvador
		Grenada
		Guyana
		Haiti
		Jamaica
		Mexico
		Nicaragua
		Peru
		Suriname
		Trinidad/Tobago
		Turk and Caicos
		Uruguay
		USA
		Venezuela

Source: PAHO, 2004.

He was an exceptionally gifted human being, a courageous researcher, and an understanding and loyal friend. If I could select one person who made a difference in oral health in the Americas, I would choose Herschel.

References

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