Managing dental caries with atraumatic restorative treatment in children: successful experience in three Latin American countries

Saskia Estupiñán-Day,[1] *Marisol Tellez,*[2] *Sundeep Kaur,*[2] *Trevor Milner,*[3] *and Alfredo Solari*[4]

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ABSTRACT

Objective. *To compare survival rates and cost differentials between the atraumatic restorative treatment (ART) technique and amalgams by type of dental personnel in Ecuador, Panama, and Uruguay.*

Methods. *Children 7 to 9 years of age in rural and urban schools with at least one lesion with initial cavitated enamel caries or a dentinal lesion on a first permanent molar were selected and randomized into the ART (intervention) or amalgam (control) group. Restoration failure was evaluated at 12 and 24 months. Cooperation and pain experienced during the procedures were measured. Cumulative and incident failure of restorations at 12 and 24 months was calculated for dentists who placed ART or amalgam restorations and auxiliaries who placed ART restorations at 12 months only.*

Results. *The total sample comprised 1 629 children. Study groups were similar by country, gender, and geographic location. Cumulative failure rate at 12 months varied by group: dentists' amalgam, 0.9% to 5.7%; dentists' ART, 2.0% to 10.5%; and auxiliaries' ART, 5.7% to 15.8%. At 24 months, higher cumulative failures were observed for the dentists' amalgam group compared with the dentists' ART group in Ecuador and Panama but not in Uruguay. Amalgam was least likely to have the best level of cooperation and an auxiliary using ART was associated with the least pain. The cost of using the ART approach for dental caries treatment, including retreatment, was roughly half that of using amalgam without retreatment.*

Conclusions. *Having auxiliary personnel perform ART will lead to treatment survival that is expected to be lower than dentists using amalgam or ART. In spite of the greater risk of failure, the rate is not unacceptable and potential cost savings are substantial.*

Key words Dental caries; dental health services; survival; dental amalgam; Ecuador; Panama; Uruguay.

[1] Regional Program on Oral Health, Pan American Health Organization, Washington, D.C., United States of America. Send correspondence to: S. Estupiñán-Day, estupins@paho.org

[2] Department of Pediatric Dentistry and Community Oral Health Sciences, Maurice H. Kornberg School of Dentistry, Temple University, Philadelphia, Pennsylvania, United States of America.

[3] Independent consultant, Technology and Health Services Delivery, Pan American Health Organization, Washington, D.C., United States of America.

[4] InterAmerican Development Bank, Washington, D.C., United States of America.

Oral diseases, including dental caries, are preventable, yet they still affect all segments of the population and more than 80% of children in the Latin America and Caribbean (LAC) region (1). Throughout the LAC region, the traditional treatment for dental caries disease remains the amalgam-based approach, which can be costly and is not always widely available, especially for disadvantaged (low-income, poorly educated, and geographically isolated) populations. The negative effects of this oral condition affect the disadvantaged disproportionately, constituting a source of infection and decreasing the quality of life (2). Dental extraction is often the only treatment effectively available to large proportions of the population because it is relatively inexpensive. This is

particularly true for people in lower socioeconomic strata and in geographically isolated areas, who generally have little or no access to dental services. In these cases, individuals may put off treatment for such long periods of time, allowing the problem to worsen, that extraction may be their only alternative.

Prevention and appropriate treatment of common oral diseases constitute a core component of primary health care, and low-income populations are particularly at risk for a variety of reasons such as lack of access to dental care, high cost of dental services, and general lack of information about the vital role oral health plays in the overall health and well-being of individuals.

The number of publications reporting on the survival of atraumatic restorative treatment (ART) sealants and ART restorations has increased considerably in recent years. ART uses manual excavation of dental caries, which eliminates the need for anesthesia and the use of expensive equipment, and restores the cavity with glass ionomer, an adhesive material that bonds to the tooth structure and releases fluoride, which stimulates remineralization (3).

Systematic reviews conducted in 2006 (4) and 2012 (5) reported various survival rates. The first review noted mean annual failure rates for single-surface ART restorations using high-viscosity glass ionomer in primary and permanent dentitions and for multiple-surface ART restorations in primary dentitions of 4.7%, 4.7%, and 17%, respectively (4). The second review concluded that the survival rates of single-surface and multiple-surface ART restorations in primary teeth over the first 2 years were 93% (confidence interval (CI) 91%–94%) and 62% (CI 51%–73%), respectively; for single-surface ART restorations in permanent teeth over the first 3 and 5 years, survival rates were 85% (CI 77%–91%) and 80% (CI 76%–83%), respectively; and for multiple-surface ART restorations in permanent teeth over 1 year, the rate was 86% (CI 59%–98%) (5). The reviews concluded that the number of studies reporting on the retention and caries-preventive effect of ART sealants was low (4).

The totality of the evidence appraised in these two reviews comes mainly from studies conducted in Asia and Africa. Studies in the LAC region conducted in different populations—such as pregnant mothers in Brazil (6) and children at high risk for caries in Suriname (7)—found a wide variation in long-term survival rates of single-surface ART in permanent dentition ranging between 29.6% (after 3 years in Suriname) and 65.2% (after 10 years in Brazil). The varying success for ART in the LAC region, its particular dental workforce structure, the lack of evidence-based information on the economic aspects of placing these restorations in public health settings in the region, and the Pan American Health Organization (PAHO) Directing Council Resolution prompted PAHO in conjunction with the ministries of health in Ecuador, Panama, and Uruguay to explore all these aspects. These countries were selected on the basis of social, economic, and cultural settings; high levels of dental caries (1); and established national salt fluoridation programs (1). The purpose of this study was twofold: to compare the survival rates of ART restorations with conventional methods such as amalgam as modalities to treat carious lesions in permanent dentition in Ecuador, Panama, and Uruguay; and to explore differences in the delivery of this service by dentists and dental auxiliaries in terms of failure rates and overall costs.

MATERIALS AND METHODS

The study was a 2-year prospective study conducted in Ecuador, Panama, and Uruguay and required the participation of two types of dental personnel: dentists (operators) and hygienists (auxiliaries). All operators and auxiliaries were licensed practitioners and were employed in the public sector, with the exception of Uruguay, where the Ministry of Health (MOH) did not employ dental hygienists. Technique and data collection training was conducted for operators and auxiliaries by two experts in ART and by PAHO staff who conducted didactic and hands-on workshops on the ART and amalgam approaches (8). Each working team consisted of a dental operator and an assistant or an auxiliary and an assistant. ART restorations (placed by operators and auxiliaries) took place at schools while amalgam restorations (placed by dentists only) took place at MOH clinics. Evaluations of the restorations by the United States Public Health Service (USPHS) (9) were conducted at 12 and 24 months by independent calibrated evaluators who conducted duplicate examinations on about 10% of the sample to assess interexaminer reliability (kappa coefficient > 0.75). All examinations except those using USPHS criteria were undertaken using a community periodontal index metallic probe (ball end 0.5 mm). The USPHS examinations were conducted with a straight caries probe. Caries status was also recorded by using criteria adapted from the manual *Oral health surveys: basic methods* (10). Data collection forms were developed to keep track of all interventions, evaluations, treatments, and consumption of time and materials (costs) for the project. Operators and auxiliaries used a time measurement form to register the activity completed in 15-minute increments.

Sample selection

Sample size was calculated with Epi Info version 6 (11) taking into consideration the latest census information on the total population for the three age groups selected, previous prevalence estimates of caries in permanent dentition for these age groups (46%), a margin error of 5%, and a confidence level of 90%. Within each country two or three regions were chosen and within them rural and urban communities were selected. Children were sampled at the school level.

The sampling unit in this study was the child and the sampling frame was the school, but the study focused on restorations performed on the first permanent molars in the child's mouth. Sample size augmentation was done to ensure that there would be enough children in the overall sample and in each of the three countries, in view of the risk of losses to follow-up (which was estimated to be 10%). Weight samples were representative of the populations of at-risk children in each nation in order to generalize the sample findings to the larger populations.

Participants were enrolled from schools in the rural and urban areas designated for the project in each country. The selected children (n = 1 629) were between 7 and 9 years old and presented at least a single lesion confirmed clinically with one of the following characteristics: cavitated enamel caries or teeth with dentinal lesions on a first permanent molar. All interventions began only after each subject was evaluated and diagnosed and inclusion criteria were met. Children were randomly as-

signed into groups at the school level by treatment to an intervention group (ART restorations) or a control group (amalgam restorations) stratified by age and gender so each child had the same chance of being assigned to one of the two groups. The following was the distribution of children to treatment arms by country: Ecuador (amalgam 56.50%, ART 56.45%), Panama (amalgam 18.65%, ART 19.15%), and Uruguay (amalgam 24.85%, ART 24.40%).

A permuted block design was used for the randomization, which was computer generated using random number seeds from a random digit table. In order to ensure balanced treatment groups within the schools, children were randomized in blocks of 4 or 10 depending on the size of the school. Centralized assignment was conducted in Washington, D.C., and information was sent privately to the research coordinator in each country.

The primary outcome measure was "failure" due to anatomical form, marginal integrity, retention, and secondary caries as defined by USPHS criteria (9). Secondary outcomes were related to cooperation and pain experienced during the procedures, which were measured with four Likert scale questions. Parental consent was obtained for the selected children. Children were not selected for the study if they had large or deep carious lesions with close proximity to the pulp, pulp inflammation or infection of the pulp, and healthy teeth without an apparent risk of caries as well as overall good health. The study was reviewed and approved by PAHO's Ethics Committee and by each country's MOH and ethics boards or committees.

Statistical analysis

Data entry was carried out in each country by a counterpart of each MOH. Country coordinators were required to enter the information into an electronic file (Epi Info 6), which had an incorporated verification program so integrity checks were performed periodically. Epi Info 6 databases were then exported to SAS 9.1 for analysis (12). Cumulative and incident failure of restorations at 12 and 24 months was calculated for dentists who placed ART or amalgam restorations, while the same was generated for auxiliaries who placed ART restorations only at 12 months as no follow-up was possible after 2 years in this group. Forward imputation procedures were conducted to ensure that data on failure at 12 months informed the data at 24 months. Specifically, if failure occurred at 12 months these data could be imputed forward—the tooth cannot "survive" at 24 months if it has failed at 12 months. Both cumulative and incident failures were characterized. The denominator for incident failure at 24 months was teeth for which survival at 12 months was actually observed and for which the 24-month data were also observed (regardless of failure or survival).

More complex analysis of the differential risk of failure was also conducted using regression analysis. Failure at 12 months was modeled comparing all three groups (dentist amalgam, dentist ART, and auxiliary ART). The analyses were conducted after controlling for age, sex, and urban or rural status. Clustering among teeth was allowed at the level of the child and the level of the "operator." The expected number of years of survival of each tooth's treatment was calculated as follows:

(1 – probability[12-month failure]) +
(1 – probability[12-month failure])
(1 – probability[24-month failure/
12-month survival])

In addition, decision trees were generated for the three countries to show the calculated probability of success and the "value" of each choice based on the expected outcome for dentists only as there were no available follow-up data for auxiliaries. One-year and 2-year costs for teeth treated by all the providers were also generated.

RESULTS

The total sample size comprised 1 629 children between 7 and 9 years old (Ecuador, n = 735; Panama, n = 572; Uruguay, n = 322). Overall, the study groups were similar by gender, country, and geographic location (Table 1).

Table 2 shows the cumulative failure rates at 12 and 24 months by country and by type of treatment and the incident failures at 24 months. In Ecuador, the cumulative failure rate was approximately 5% higher when the tooth was treated by a dentist using ART than when the tooth was treated by a dentist using amalgam. At 12 months, the failure rate for teeth treated by auxiliary personnel using ART was another 5 percentage points higher than for dentists using ART. In Panama, the cumulative failure rates were approximately double for dentists using ART compared with dentists using amalgam. Both rates were lower than the failure rate for a dentist using ART in Ecuador. In contrast, the failure rate in Panama for auxiliary personnel using ART was similar to the rate in Ecuador. In Uruguay, the failure rate for dentists using amalgam was higher than the failure rate for dentists using ART and similar to the rate for auxiliary personnel using ART at 12 months. The failure rate for dentists using ART remained lower than the failure rate for dentists using amalgam at 24 months. In terms of cooperation and pain measures, the distributions did not differ substan-

TABLE 1. Baseline differences in sociodemographic characteristics by treatment group, Ecuador, Panama, and Uruguay, 2002–2005

Characteristic	Amalgam		Autramatic restorative treatment	
	No.	%	No.	%
Gender				
Male	368	49.1	418	48.1
Female	393	50.8	450	51.8
Age (years)				
7	89	12.2	139	17.3
8	312	38.2	350	37.2
9	360	48.5	389	45.4
Country				
Ecuador	344	56.5	391	56.4
Panama	269	18.6	331	36.8
Uruguay	148	24.8	174	24.4
Geographic location				
Urban	465	62.2	537	63.1
Rural	296	37.7	331	36.8

TABLE 2. Cumulative failure with 12-month failure imputed forward and incident failure (for 24 months only if not failed at 12 months) (U.S. Public Health Service criteria), Ecuador, Panama, and Uruguay, 2002–2005

	Ecuador						Panama						Uruguay					
	Dentist				Auxiliary		Dentist				Auxiliary		Dentist				Auxiliary	
	Amalgam		ART[a]		ART[a]		Amalgam		ART[a]		ART[a]		Amalgam		ART[a]		ART[a]	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
12 months	43	5.7	127	10.5	165	15.8	6	0.9	14	2.0	101	15.4	12	5.6	12	3.9	15	5.7
24 months	70	11.2	168	16.7	NA[b,c]	NA[b,c]	8	1.4	22	3.5	NA[b]	NA[b]	15	7.1	19	6.2	NA[b]	NA[b]
Incident failure for 24 months	NA[b]	4.8	NA[b]	4.6	NA[b]	NA[b]	NA[b]	NA[b]	NA[b]	1.2	NA[b]	NA[b]	NA[b]	1.5	NA[b]	2.4	NA[b]	NA[b]

[a] ART: autramatic restorative treatment.
[b] NA: not applicable.
[c] Data collection on survival of restorations placed by auxiliaries was done only at 12 months.

tially. In each country, dental amalgam was least likely to have the best level of cooperation and an auxiliary using ART was associated with the least pain. In Panama and Uruguay, a dentist using ART yielded less pain than a dentist using amalgam.

Failure data at 12 months to estimate the odds ratios of failures for teeth on which ART was performed by dentists or auxiliaries were compared with data for teeth on which dentists used amalgam (Table 3). A dentist using ART had an odds ratio of 1.75 ($P < 0.05$), even when controlling for country, age, and sex; weighting the data; and allowing for clustering by operator. This relationship was insensitive to the exclusion of variables other than the treatment group and to clustering at the level of the child rather than the operator. The odds ratio for auxiliary ART—when controlling for other variables, weighting, and allowing for clustering by operator—was 3.43 ($P < 0.05$).

A tooth treated by a dentist using amalgam in Ecuador would last approximately 0.1 year longer (over a 2-year period) than a tooth treated by a dentist using ART. Of every 1 000 teeth treated by a dentist using amalgam 56 teeth would need to be retreated at the end of the first year. Of them, assuming they received the same treatment and had the same failure rate, three would need additional treatment at the end of the second year. At the end of the second year, 45 more teeth would need to be retreated, even though they survived the first year. Thus, with a dentist using amalgam, there would need to be 104 retreatments after treating 1 000 teeth initially. An auxiliary using ART on 1 000 teeth in Ecuador would be associated with 163 retreatments after only 1 year. Similar analyses were performed for Panama and Uruguay. The difference in survival over 2 years was very small in Panama. In Uruguay, the treatment of teeth by dentists using ART had a longer expected survival over 2 years than the treatment of teeth by dentists using amalgam (Table 4).

The cost of dentists using amalgam was always higher than the cost of dentists using ART (Table 5). This cost was driven by nonpersonnel costs. The cost of dentists performing procedures in Uruguay was much higher than in Ecuador and Panama. The cost of auxiliaries using ART was the lowest in all countries. In addition, the average times were 10–15 minutes, although dentists in Panama were able to perform the amalgam procedure in less than 9 minutes, and auxiliary personnel in Panama and Uruguay required more than 15 minutes to perform ART.

Finally, analysis of the effect of three different options in Ecuador over an interval of 1 year of effectiveness used a tree (Figure 1) with a decision node indicating the choice (which provider or treatment in Ecuador) and then showed branches with the three choices: dentist amalgam, dentist ART, auxiliary ART. On each of these branches was a chance node (denoted by a circle) with two possibilities: year 1 success and year 1 failure. The probability of failure shown under each "year 1 failure" branch came directly from the study's data. The "#" symbol under each "year 1 success" branch indicated that it had the remainder of the probability—that is, 1 – the probability of failure. The value at each end node represents how the outcome was counted: 0 for failure and 1 for success. The rolled back (or solved) version of this tree showed that the dentist amalgam branch would be chosen if the only criterion were the number or probability of success. The result showed the calculated probability of success and the value of each choice based on the expected outcome. The dentist amalgam had the highest expected value.

The 2-year analysis had two chance nodes. The first was failure in year 1. The second was failure in year 2. Again, each probability came from the data. The result of success in both years was counted as a value of 2, indicating the number of years of success. A suc-

TABLE 3. Odds ratios of failures of alternatives to amalgam treatment at 12 months, Panama, Ecuador, and Uruguay, 2002–2005

Atraumatic restorative treatment	Group only	Group and country	Group, country, and age	Group, country, age, and sex[a]	Group, country, age, and sex weighted clustering
By dentist	1.88[b]	1.81[b]	1.80[b]	1.81[b]	1.75[b]
By auxiliary	4.19[b]	4.10[b]	4.07[b]	4.18[b]	3.43[b]

[a] Results are insensitive to clustering by child with multiple teeth or by operator who treated multiple teeth.
[b] $P < 0.05$.

TABLE 4. Expected years of treatment survival by group and country for dentists placing amalgams or autramatic restorative treatment, Panama, Ecuador, and Uruguay, 2002–2005

	Ecuador		Panama		Uruguay	
	Amalgam	Autramatic restorative treatment	Amalgam	Autramatic restorative treatment	Amalgam	Autramatic restorative treatment
Years of treatment survival	1.84	1.75	1.98	1.95	1.87	1.9
End of year 1 retreatment	56	105	9	19	57	40
Per 1 000 children, end of year 2 retreatment of those retreated at end of year 1	3	11	0	0	3	2
Per 1 000 children, end of year 2 retreatment of those treated only at baseline	45	41	4	11	14	23
Total retreatments	104	157	13	30	74	65

cess in year 1 but failure in year 2 was counted as 1 for 1 year of success. A failure in year 1 counted as 0. The expected number of years of success (with a maximum of 2) was then determined by the probability of failure in each year. In Ecuador, the dentist amalgam had a higher number of expected years of success (1.84 years) compared with dentist ART (1.75 years). Thus, based only on the criterion of expected years of success, the dentist amalgam would be chosen.

DISCUSSION

While the odds of treatment failure were higher for an auxiliary using ART than for a dentist using amalgam in Ecuador and Panama, substantial cost savings could be achieved. Even including the cost of equipment and personnel cost per procedure and factoring in the cost of retreating teeth for which the treatments fail, the total cost of having auxiliary personnel treat and retreat over a 1-year period was half the cost of having a dentist use ART and less than one-third the cost of having a dentist use amalgam. It is true that, in general, auxiliaries are less expensive than dentists. However, the cost-savings calculations were performed factoring in the differences in salary. Thus, having auxiliary personnel use ART appeared to be a good investment over a 2-year period. Future studies should aim to conduct evaluations over a longer period of time to validate whether these initial positive results sustain in the long term. It is important to note that having auxiliary personnel use ART also encouraged cooperation and seemed to produce less pain, which is consistent with other ART studies that have been found to cause less pain and discomfort to the patient compared with conventional treatment (13, 14).

Even if ART is provided at the lowest cost service modality, and even under a failure scenario, it produces acceptable outcomes. In Ecuador and Panama, the effectiveness of ART delivered by dentists compared with dental auxiliaries was similar; in Uruguay, the results were even better. The costs of employing the ART approach for dental caries treatment, including retreatment, are roughly half the cost of amalgam without retreatment. The differences found among settings and countries with different epidemiologic profiles and dental delivery systems will be useful for ministers of health and health planners as they might provide guidance for the effective translation and scaling up of dental services for children in diverse locales.

Finally, the choice for many children and their families is not dental treatment by dentist versus auxiliary personnel or ART versus amalgam but rather dental treatment delivered by auxiliary personnel using ART versus no dental services or inferior dental services, such as extractions of decayed teeth.

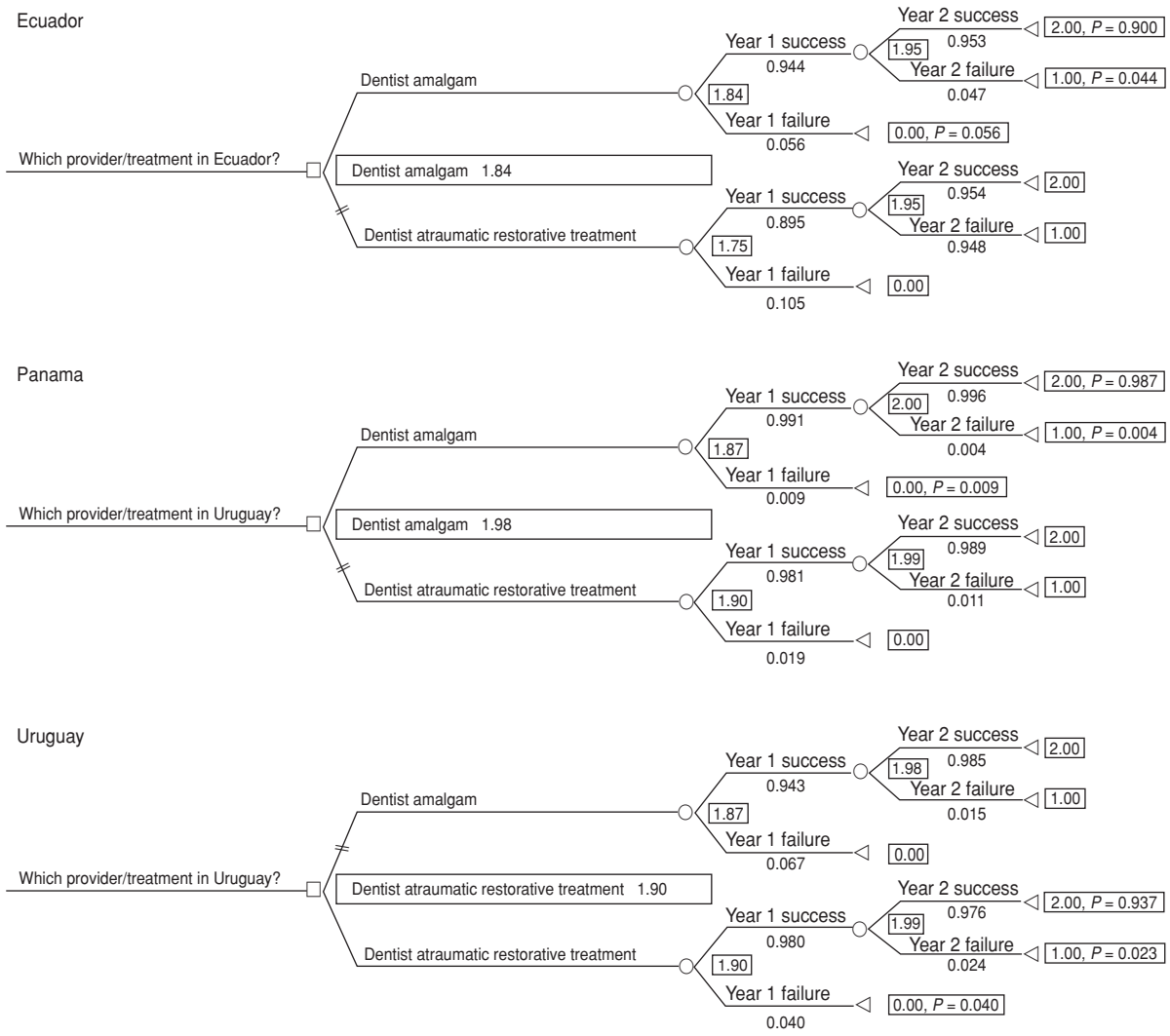
Some limitations to this study are worth mentioning. First, treatments were performed in different settings (schools versus MOH clinics), which could have resulted in selection bias. Although no analysis was carried out to explore potential differences in survival in both settings, a recent study conducted in India designed to specifically explore this issue found that ART restorations done in a hospital dental setup were not proven to be better than restorations placed in school environments (15). Second, operators were not blinded (nor could they be) to the treatment modality. Dentists and auxiliaries

TABLE 5. Cost per amalgam and autramatic restorative treatment (ART) therapy by type of operator and average times taken for procedures, Panama, Ecuador, and Uruguay, 2002–2005

	Ecuador			Panama			Uruguay		
	Dentist		Auxiliary	Dentist		Auxiliary	Dentist		Auxiliary
	Amalgam	ART	ART	Amalgam	ART	ART	Amalgam	ART	ART
n	888	1 336	1 261	677	769	693	232	341	576
Supplies[a]	$1 470.00	$2 372.88	$1 225.72	$3 611.55	$4 602.41	$2 132.11	$1 411.98	$1 411.81	$1 271.81
Equipment[a]	$3 905.99	$317.19	$0.00	$3 779.44	$298.58	$0.00	$2 521.89	$117.87	$0.00
Average nonpersonnel cost per procedure[a]	$6.05	$2.01	$0.97	$10.92	$6.37	$3.08	$16.96	$4.57	$2.21
Personnel cost per procedure[a]	$1.72	$1.63	$0.51	$2.03	$2.63	$0.40	$16.69	$14.80	$1.16
Total cost per procedure[a]	$7.77	$3.64	$1.48	$12.95	$9.00	$3.48	$33.64	$19.38	$3.37
Mean time (minutes)	13.22	12.48	10.50	8.79	11.35	16.72	15.71	13.94	22.32

[a] Costs are in U.S. dollars.

FIGURE 1. Decision probability trees, Ecuador, Panama, and Uruguay, 2002–2005



followed standardized training protocols that aimed to minimize particular predisposing attitudes toward invasive versus noninvasive interventions. The substantial between-country differences in survival rates for restorations placed in Ecuador compared with Panama and Uruguay did not seem to be the result of training issues or variations in the interpretation of failure or operators' unfamiliarity with the ART technique.

This research suggests that auxiliary personnel performing ART will lead to treatment survival that is expected to be lower than that of dentists using amalgam or dentists using ART in most cases. In spite of the greater risk of failure, the rate is not unacceptable and the cost savings that can be obtained are larger. Implementation of the ART system in schools and on a community-wide basis, and integrated into the primary health care system, may be an important and effective way to increase access to basic dental services for currently underserved sectors of society. The use of more auxiliary personnel may ensure more access to basic oral health care services in regions of LAC where none or few now exist. A recent review (16) of 1 100 reports regarding dental therapists and their work in various countries documents that this type of oral health personnel can effectively expand access to dental care, especially for children, and that the care they provide is technically competent, safe, and effective. Although the report makes reference only to Caribbean countries, findings from the current study support the use of ancillary dental personnel for LAC countries.

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Conflict of interests. None.

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RESUMEN

Control de la caries dental mediante tratamiento restaurador atraumático en niños: experiencia exitosa en tres países de América Latina

Objetivo. Comparar las tasas de supervivencia de las restauraciones y las diferencias en cuanto a costo según el tipo de profesional odontológico, entre la técnica de tratamiento restaurador atraumático (TRA) y las amalgamas en Ecuador, Panamá y Uruguay.

Métodos. Se seleccionaron niños de 7 a 9 años de edad, de escuelas rurales y urbanas, que presentaban como mínimo una lesión inicial cavitada de caries del esmalte o una lesión de la dentina en un primer molar permanente, y se distribuyeron aleatoriamente en el grupo sometido a TRA (intervención) o en el grupo tratado con amalgamas (control). Se evaluó el fracaso de la restauración a los 12 y 24 meses. Se midió el grado de cooperación y el dolor observados durante los procedimientos. Se calculó el fracaso acumulado e incidental de las restauraciones a los 12 y 24 meses para los dentistas que aplicaron restauraciones de tipo TRA o amalgamas, y únicamente a los 12 meses para el personal auxiliar que llevó a cabo restauraciones de tipo TRA.

Resultados. La muestra total incluyó a 1 629 niños. Los grupos de estudio fueron similares en cuanto a país, sexo y ubicación geográfica. La tasa de fracaso acumulado a los 12 meses varió según el grupo: fue de 0,9 a 5,7% para la amalgama aplicada por dentistas; de 2,0 a 10,5% para el TRA aplicado por dentistas; y de 5,7 a 15,8% para el TRA aplicado por personal auxiliar. A los 24 meses, se observaron mayores fracasos acumulados en el grupo de amalgamas aplicadas por dentistas en comparación con el grupo de TRA aplicado por dentistas en Ecuador y Panamá pero no en Uruguay. Fue menos probable que la aplicación de amalgama obtuviera el mejor grado de cooperación, y la aplicación de TRA por personal auxiliar se asoció con la menor intensidad de dolor. El costo de usar el método de TRA en el tratamiento de la caries dental, incluido el retratamiento, fue aproximadamente de la mitad del costo del empleo de amalgama sin retratamiento.

Conclusiones. La restauración mediante TRA llevado a cabo por personal auxiliar logrará una supervivencia presumiblemente inferior a la obtenida por la aplicación de amalgama o TRA por dentistas. A pesar del mayor riesgo de fracaso, la tasa es admisible y la potencial reducción de costos es importante.

Palabras clave Caries dental; servicios de salud dental; supervivencia; amalgama dental; Ecuador; Panamá; Uruguay.