

Teaching Atraumatic Restorative Treatment in U.S. Dental Schools: A Survey of Predoctoral Pediatric Dentistry Program Directors

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Abstract: The International Dental Federation and World Health Organization have promoted the use of Atraumatic Restorative Treatment (ART) in modern clinical settings worldwide. In the United States, the practice of ART is not believed to be widely used, which may be a result of little attention given to ART training in predoctoral pediatric dentistry curricula in U.S. dental schools. This study investigated the extent of clinical and didactic instruction on ART provided in U.S. dental schools by surveying the predoctoral pediatric dentistry programs in 2010. Of the fifty-seven directors asked to complete the survey, forty-four responded for a response rate of 77 percent. Of these forty-four programs, 66 percent reported providing clinical training on ART, though only 14 percent provide this training often or very often. The types of ART training provided often or very often included interim treatment (18 percent) and single-surface cavities (14 percent) in primary teeth. However, ART was said to be rarely taught as a definitive treatment in permanent teeth (2 percent). Attitude was a major predictor, for clinical training provided and using professional guidelines in treatment decisions were associated with a positive attitude towards ART. These predoctoral pediatric dentistry programs used ART mainly in primary, anterior, and single-surface cavities and as interim treatment. As ART increases access of children to dental care, the incorporation of the ART approach into the curricula of U.S. dental schools should be facilitated by professional organizations.

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Atraumatic Restorative Treatment (ART) was officially adopted by the World Health Organization in the 1990s.¹ It was originally proposed as a caries control system that could be used to treat children in field settings in developing countries, where access to conventional dental care is not possible. However, after encouraging research results, ART application has gradually increased in modern dentistry, and it currently has many applications in developed countries, especially for very young children who are being introduced to oral care,² patients with high dental anxiety,^{2,3} homebound patients,⁴ patients with mental and physical challenges,⁵ and patients at high risk for caries who can benefit from ART as an intermediate treatment to stabilize conditions.⁶ In addition, because of its shorter clinical sessions and reduced cost of treatment,⁷

the ART approach could be of particular benefit to underserved children who have high treatment demands, difficult access to dental care, and limited financial resources.

In a systematic review,⁸ no significant differences were found between the longevity of single-surface ART and amalgam restorations in permanent teeth after three years. Other studies with a follow-up period of six years have also found that when using high viscosity glass ionomer cements, ART had better clinical results than conventional amalgam restorations.^{9,10} A recent meta-analysis found that survival of ART restorations was 93 percent over two years in single-surface restorations in primary teeth and 80 percent over five years in single-surface restorations in permanent teeth.¹¹ Those results qualified ART as an important and effective evidence-based

treatment to meet the American Dental Association (ADA) specification for quality restorations to manage single-surface caries lesions.¹²

The American Academy of Pediatric Dentistry (AAPD) recommends the use of an interim version of ART, the Interim Therapeutic Restoration (ITR), which is identical to ART in technique—scooping out dental caries using hand instruments and placing glass ionomer (GI) to restore the resultant cavity—but is different in its therapeutic goals. ITR is recommended by the AAPD to be used “in children whom traditional cavity preparation and/or placement of traditional dental restorations are not feasible or need to be postponed and in children with multiple open carious lesions, prior to definitive restoration of the teeth.”¹³ At a public health level, the Indian Health Service, in its most recent initiative to prevent Early Childhood Caries (ECC), promoted the use of ART to reduce the need for children having to go to the operating room to receive dental treatment.¹⁴

While recent global and national recommendations have been in favor of ART, the use of this procedure is not well established in the United States. For example, in a recent study that compared the use of some minimal invasive dentistry (MID) techniques such as ART, fluoride remineralization, and other techniques between civilian and federal service dentists, 36 percent of the respondents selected “some” and 13 percent selected “none” for their knowledge of ART technique.¹⁵ Similarly, in a 2003 national survey of general dental practitioners, 44 percent of the respondents reported using ART as a restorative procedure to treat children often or very often; however, 38 percent said they knew nothing about ART, and 40 percent agreed that further training on ART was very desirable.¹⁶

Given the strong evidence of the impact of dental education and training on future dentists’ attitude and behavior,¹⁷⁻²⁰ the underuse of ART may reflect that little attention is given to ART in dental education. However, there have been no previous attempts to gather information about specific parts of the curriculum devoted to teaching ART in the United States or to the types of clinical experiences U.S. dental students have with ART. Therefore, the purpose of this study was to survey predoctoral pediatric dental program directors about factors related to the didactic instruction and clinical experiences of ART in their programs and their attitudes towards this procedure. This information will provide insights into the current role of dental schools in introducing ART into the dental care system and future possibilities

for supporting this procedure as a valid treatment option especially for those for whom traditional care is inaccessible or impractical.

Methods

The web-based survey was developed in fall 2009 and spring 2010. It was pretested for content validity, using cognitive analysis (consulting and pretesting the instrument with experts) by six faculty members from the Department of Preventive and Community Dentistry, four faculty members from the Department of Pediatric Dentistry, and one faculty member from the Department of Operative Dentistry, all at the University of Iowa. None of these faculty members was involved in the original development of the instrument. Pilot testing for face validity was carried out by two pediatric dentistry senior residents and two dental public health senior residents, also from the University of Iowa. Based on comments from the pretesters and the study statistician, the survey was modified for improved clarity and validity. Submitting a completed questionnaire constituted the subjects’ consent. The study was approved by the University of Iowa Institutional Review Board.

A list of contacts of pediatric dentistry department chairs in U.S. dental schools was obtained from the AAPD and was verified by comparison with the ADA list of accredited dental schools as of April 2010. In May 2010, an invitation letter was mailed with a letter of explanation to the chairperson of the pediatric dentistry department or division at the then fifty-seven U.S. dental schools. After a week, an e-mail including a cover letter that described confidentiality safeguards, the link to the web survey, and a unique identification number was sent to all programs. Two follow-up surveys were e-mailed to nonrespondents two and four weeks after the first e-mail.

The survey questioned predoctoral program directors about the characteristics of their programs and the patient population they serve. Besides demographic characteristics of the program, the survey included questions about the use of behavior management techniques in the program and the use of various MID techniques. In addition, the directors answered questions about themselves and their attitudes towards ART.

The respondents were given the definition of ART as “a procedure based on removing carious tooth tissues using hand instruments alone and restoring

the cavity with an adhesive restorative material”²¹ and were asked to consider this definition in their responses. The program directors were asked to report the current level of clinical experience their students receive on ART by answering this question: “how often do the dental students use ART as a caries management technique for their patients?” Responses were measured on a five-point scale (never=1 to very often=5). The didactic instruction on ART was measured by this question: “does your program’s didactic instruction teach that preparing cavities using only hand instruments can be a proper technique in certain situations?” The response to this question was dichotomized as yes or no.

In order to get a more parsimonious model and minimize the number of variables that would be used in the final regression model, two scales (composite variables) were constructed from this survey. The first composite variable was the use of MID techniques, which included fourteen MID procedures that were agreed on during the cognitive analysis phase of questionnaire development. The scale was the sum of responses of the fourteen questions each measured on a five-point scale (never=1, rarely=2, sometimes=3, often=4, most often=5). The internal consistency of this scale was measured by Cronbach’s alpha, which was 0.7, suggesting a high level of consistency. The scale was used as a predictor variable in our model

and had a mean of 39 (± 6) in our study sample. For this scale, a respondent who scored “never” all the time would have a total score of 14, and a respondent who scored “most often” all the time would have a total score of 70.

The second composite variable was about program directors’ attitudes towards ART, and it was used as an intermediate variable in our model (acted both as a predictor and outcome variables; see Figure 1). The agreement or disagreement of program directors with ten statements about ART was measured on a five-point Likert scale. The scale summed the scores for each subquestion, ranging from 1=strongly disagree to 5=strongly agree. Therefore, the most negative attitude would be 10, and the most positive attitude would score 50 on this scale. The scale had a Cronbach’s alpha of 0.74, and the mean for the study sample was 39 (± 6).

The key independent variables included in the analyses were program director’s age, gender, number of years since graduation, frequency of the use of behavior management techniques used with children (nonpharmacological, protective stabilization, nitrous oxide, sedation, general anesthesia), frequency of use of amalgam in the program (primary teeth and permanent teeth), use of MID techniques in the program (composite variable), and program director’s attitude towards ART (composite vari-

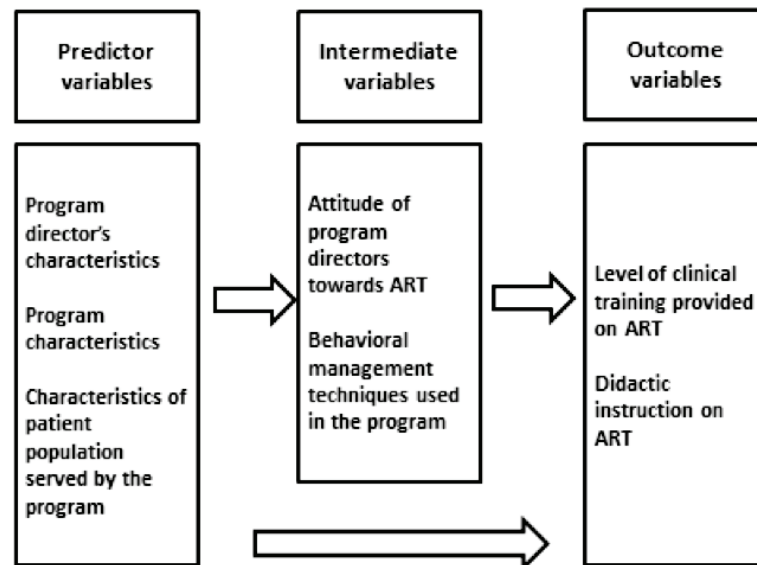


Figure 1. Conceptual model of study variables

able). Figure 1 shows the conceptual framework of the variables in this study.

The responses on the online survey software were exported directly to an Excel spreadsheet accessible to the principal investigator under a protective password. The data were exported into SPSS data files, and the PASW Statistics 18²² was used to carry out the analysis. Statistical analyses included descriptive statistics to describe sample characteristics, bivariate analyses to explore associations between predictor and outcome variables, and multivariable modeling to assess the variables that may explain our three outcome variables. Logistic regression was used for the “didactic instruction of ART” outcome variable, and stepwise and backward multiple linear regression were used for “the level of clinical training on ART” and the “attitude of program directors toward ART” outcome variables. For the two scales used in this study, the use of MID scale and attitude towards ART scale, an internal consistency was assessed by using Cronbach’s alpha. All tests were assessed at the 0.05 level of statistical significance.

Results

Surveys were returned from forty-four of the fifty-seven dental schools, for a response rate of 77 percent. Responding and nonresponding dental schools were compared in a descriptive way according to variables obtained from the American Dental Education Association (ADEA) dental schools’ profile such as location of school, year established, off-site rotations, presence of advanced standing option for foreign-trained dentists, association with other degrees (M.P.H., Ph.D., etc.), and enrollment by race, gender, and number. No response bias was detected based on these comparisons.

Seventy percent of the respondents were male; 70 percent had graduated from a U.S. dental training program; and 25 percent had completed their training in hospital-based programs. Seventy-three percent of the program directors who responded to this survey were board-certified, and 39 percent had other post-D.M.D./D.D.S. training or degrees. When discussing restorative treatment options with their students, all the responding program directors cited children’s caries risk as very important or important; 81 percent cited parental preference as very important or important; and 27 percent cited patient insurance status or source of payment as very important or important. Approximately 95 percent

of these program directors reported that continuing education was very influential or influential on their knowledge regarding different restorative options, and 83 percent cited postdoctoral training as a very influential or influential source of their attitudes.

According to their program directors, students in 86 percent of the responding programs performed a caries risk assessment with each new patient. Additionally, dental students in thirty-three programs were said to provide preventive care such as diet counseling and fluoride application to children three years or younger, and students in sixteen dental schools were said to provide restorative care to children three years or younger. The patient population served by the responding programs was reported by their directors to be mainly financed by Medicaid and other public insurance (64 percent \pm 26), and 40 percent were said to treat children with special health care needs.

Level of Clinical Training on ART

The majority of the responding program directors (66 percent) reported that their program provided clinical instruction on ART to their predoctoral students; however, only 14 percent used this technique very often or often as a caries management technique. Table 1 shows the types of ART used by dental students in these programs. ART was reported to be used more in anterior primary teeth, in single surface cavities, and as an interim treatment. Regarding materials used very often or often in ART restorations, GI was the material of choice in posterior teeth (45 percent) and in anterior teeth (49 percent). All (100 percent) of the respondents said their program never used amalgam in posterior teeth with ART restorations, while composite-based materials were used in posterior teeth by only 3 percent of responding programs.

Among the 34 percent of the respondents who answered no to the question “Does your program provide clinical instruction on ART?,” 16 percent cited “students should learn ideal restorations first” as a reason for not including ART in their training program. Other reasons cited were “no space in the curriculum” (11.4 percent), “insufficient scientific evidence that supports the use of ART” (7 percent), and “ART is a suboptimum treatment” (5 percent). In multiple linear regressions, three predictor variables—attitude toward ART composite variable, use of nonpharmacological behavior management techniques with children, and parental preference—remained significant as important factors in selecting restorative treatment in the final model (Table 2).

Table 1. Frequency of use of types of ART in responding predoctoral pediatric dentistry programs that answered yes to providing clinical training on ART (N=29; 66% of our sample)

| Type of ART Used | Never N (%) | Rarely N (%) | Sometimes N (%) | Often N (%) | Very Often N (%) | Total N (%) |
|---|----------------|-----------------|--------------------|----------------|---------------------|----------------|
| ART in anterior primary teeth | – | 8 (27.6%) | 15 (51.7%) | 4 (13.8%) | 2 (6.9%) | 29 (100%) |
| ART in anterior permanent teeth | 8 (27.6%) | 14 (48.3%) | 6 (20.7%) | 1 (3.4%) | – | 29 (100%) |
| ART in posterior primary teeth | – | 13 (44.8%) | 11 (37.9%) | 1 (3.4%) | 4 (13.8%) | 29 (100%) |
| ART in posterior permanent teeth | 4 (13.8%) | 17 (58.6%) | 4 (13.8%) | 3 (10.3%) | 1 (3.4%) | 29 (100%) |
| ART in single-surface cavities in primary teeth | – | 11 (37.9%) | 12 (41.4%) | 3 (10.3%) | 3 (10.3%) | 29 (100%) |
| ART in single-surface cavities in permanent teeth | 4 (14.3%) | 17 (60.7%) | 4 (14.3%) | 2 (7.1%) | 1 (3.6%) | 28 (100%) |
| ART in multi-surface cavities in primary teeth | 4 (13.8%) | 12 (41.4%) | 9 (31.0%) | 3 (10.3%) | 1 (3.4%) | 29 (100%) |
| ART in multi-surface cavities in permanent teeth | 11 (37.9%) | 11 (37.9%) | 3 (10.3%) | 3 (10.3%) | 1 (3.4%) | 29 (100%) |
| ART as interim treatment in primary teeth | – | 5 (17.2%) | 16 (55.2%) | 5 (17.2%) | 3 (10.3%) | 29 (100%) |
| ART as interim treatment in permanent teeth | 2 (7.1%) | 13 (46.4%) | 10 (35.7%) | 2 (7.1%) | 1 (3.6%) | 28 (100%) |
| ART as definitive treatment in primary teeth | 7 (24.1%) | 12 (41.4%) | 7 (24.1%) | 2 (6.9%) | 1 (3.4%) | 29 (100%) |
| ART as definitive treatment in permanent teeth | 17 (60.7%) | 9 (32.1%) | 1 (3.6%) | 1 (3.6%) | – | 28 (100%) |

Table 2. Results of multiple linear regression of variable clinical training on ART provided in predoctoral pediatric dentistry clinical training in responding programs

| Predictor Variable | Beta Coefficient | p-value |
|---|------------------|---------|
| Parental preference as an important factor in selecting restorative treatment | 0.35 | 0.009 |
| Use of non-pharmacological behavior management techniques with children | 0.36 | 0.007 |
| Attitude of department chair towards ART | 0.27 | 0.046 |

R square=0.4; F=4.3, p<0.046 (using the stepwise method and confirmed by backward and forward regression)

Those variables explained 40 percent of the variation in the level of clinical training provided in these programs.

Didactic Instruction on ART

The majority of the respondents (89 percent) selected yes for the question “Does your program provide any didactic instruction on ART in your curriculum?” and 77 percent selected yes for the question “Does your program’s didactic instruction teach that preparing cavities using only hand excavators can be a proper technique in certain situations?” Most of the didactic instruction was reported to be in lecture format (86 percent), electronic or paper handouts (63 percent), assigned readings (54 percent), case-based learning (51 percent), small-group discussion (42 percent), and video presentation (7 percent).

A logistic regression model was performed to assess the impact of the predictor variables on the likelihood that respondents provided any didactic instruction on ART. The final model included three variables: the variable “proportion of children older than 13 years treated by the dental students”; the

agreement with the statement “a formal caries risk assessment should be carried out periodically and thoroughly for all children in the pediatric dental office”; and the composite variable “attitude towards ART” (Table 3). The full model containing all predictors was statistically significant, indicating that the model was able to distinguish between respondents who provided and did not provide didactic instruction on ART. The model as a whole explained between 29 and 47 percent of the variance in didactic instruction on ART and correctly classified 85 percent of the cases. As shown in Table 3, two variables made a unique statistically significant contribution to the model: attitude of program directors towards ART and dental schools that had a majority of their patient population older than 13 years. The strongest predictor for providing didactic instruction on ART was directors who strongly agreed with the statement that “a formal caries risk assessment should be carried out periodically and thoroughly for all children in the pediatric dental office,” which had an odds ratio of 5.1; however, this result was not statistically significant.

Attitudes of Program Directors Towards ART

These forty-four program directors' attitudes towards ART had a mean score of 39 ± 5 . (On this scale, the most negative attitude would be 10, and the most positive attitude would score 50.) The lowest score on this scale was 27, and the highest was 49. Bivariate analysis showed that directors who considered professional guidelines and child's age and behavior as very important factors when discussing treatment options with their students had more positive attitudes towards ART. Program directors who disagreed with the statement "definitive treatment is always the treatment of choice when treating pediatric patients" scored higher on the attitude scale.

In the final regression model of the composite variable "attitude towards ART," two variables stayed significant and explained 32.4 percent of the variation of program directors' attitudes towards ART (Table 4). These variables were disagreement with the statement "definitive restorations should be the treatment of choice regardless of other factors" and "professional guidelines and standard of care are an important factor in selecting restorative treatment."

Discussion

The first step to introduce any new procedure to a health system is the training of professionals, al-

lowing them to understand the philosophy behind the new technique as well as the actual technique itself. Studies that have investigated barriers to using ART found that professionals' lack of training on ART was a major obstacle.^{23,24} Since ART is based on good evidence and has many applications in modern clinical settings,²⁻⁶ providing dental students with didactic and clinical instruction on ART would be essential to make ART a viable restorative treatment option when practitioners discuss treatment plans with parents or other decision makers. In a study that collected information about education in cariology for dental students in Europe, 83 percent of schools (102 dental schools) supported the inclusion of ART in the curriculum.²⁵ However, no such information exists for the United States to the best of our knowledge since our study is the first to investigate the didactic and clinical instruction provided on ART in predoctoral pediatric dentistry programs in U.S. dental schools.

The response rate to our survey of 77 percent was considered to be good, suggesting that the findings may be generalized to all dental schools. Moreover, no response bias was found between responding dental schools and nonresponding dental schools when they were compared on dental school characteristics obtained from the ADEA website.²⁶ This consistency further suggests that our sample can be considered representative of all U.S. dental schools. However, the representativeness of the program directors themselves are not guaranteed

Table 3. Results of logistic regression of variable didactic instruction on ART

| Predictor Variable | Mann-Whitney U-test | B coefficient | p-value | Odds Ratio | 95% CI for Odds Ratio |
|--|---------------------|---------------|---------|------------|-----------------------|
| Proportion of children older than 13 years treated by the dental students | 80, $p < 0.04$ | -0.075 | 0.037 | 0.927 | 0.864-0.995 |
| Agreement with the statement "A formal caries risk assessment should be carried out periodically and thoroughly for all children in the pediatric dental office" | 105, $p < 0.02$ | 1.627 | 0.08 | 5.1 | 0.62-31.6 |
| Attitude of program directors towards ART | 128, $p < 0.3$ | 0.232 | 0.046 | 1.27 | 1.004-1.59 |

Note: For this model, Cox and Snell $R^2 = 29\%$, Nagelkerke $R^2 = 47\%$.

Table 4. Results of multiple linear regression of survey respondents' attitudes about ART

| Predictor Variable | Spearman Rho Ranking Test | Beta Coefficient | p-value |
|---|---------------------------|------------------|---------|
| Professional guidelines and standard of care as an important factor in selecting restorative treatment | 0.48, $p < 0.001$ | 0.417 | 0.003 |
| Disagreement with the statement "Definitive restorations should be the treatment of choice regardless of other factors" | 0.41, $p < 0.005$ | 0.288 | 0.037 |

R square=0.32; F=5, $p < 0.037$ (using the stepwise method and confirming the results with forward and backward regression)

as the characteristics of program directors were not directly compared.

The results revealed that only 14 percent of the respondents used ART often or very often, and 23 percent used it rarely as a caries management technique. A study conducted in 2003 found that 36 percent of a national sample of U.S. dental practitioners had received hands-on training on ART, while 38 percent had received none.¹⁶ In that same study, 44 percent of responding general dental practitioners cited the use of ART in their current practices often or very often and 28 percent used it rarely or never. In a study that compared dental caries management decisions for primary teeth by general practitioners in England and Japan, 30 percent of respondents in Japan used ART for a single distal cavity in a vital tooth without history of pain and 62 percent used traditional restorative treatment. Using the same clinical scenario, 57 percent of English respondents used ART, and 35 percent used traditional restorative treatment.²⁷

The use of ART mainly in primary teeth and as an interim treatment found in our study agrees with the use of ART in pediatric dentistry residency programs²⁸ and the new revision of AAPD guidelines on the use of ART. While in 2001, the AAPD adopted a policy that recognized ART “as an acceptable treatment for the management of caries when traditional dental restorations are not possible,”²⁹ the 2008 revision gave the procedure another name, Interim Therapeutic Restoration (ITR), which is the same technique as ART; however, the therapeutic goal for ITR was limited to “a beneficial provisional technique.”¹³ Thus, the AAPD endorsed only the interim version of ART in modern dental practice.

The variable “use of nonpharmacological behavior management techniques with children” alone and with controlling for other variables explained 36 percent of the variation in our outcome variable “level of clinical instruction on ART.” Our survey results showed that 94 percent of responding predoctoral pediatric dentistry programs used nonpharmacological techniques more often to manage children’s behaviors. Thus, in settings that depend mainly on nonpharmacological behavior management techniques to gain children’s cooperation, ART techniques would be valuable because of its atraumatic, patient-friendly nature.² The second variable that explained 35 percent of the variation in the outcome was “parental preference as an important factor in selecting restorative treatment.” Parental preference has been always a very important factor in child treatment planning,^{2,29} and acceptance of ART

among patients and their parents has been found to be high when the procedure and its therapeutic goals were explained properly to them.^{3,5,30} The third variable was the attitude of program directors toward the ART scale, which explained 27 percent of the variation in the level of training provided on ART. This was expected within the frame of the well-known influence of attitude on behavior and training provided to students.³¹

Program directors who did not provide any training on ART in their curricula justified that for different reasons. Reasons that were selected more frequently—such as “dental students should learn ideal restorations first,” “insufficient scientific evidence that supports the use of ART,” and “it is suboptimum treatment”—reflect a very negative attitude towards ART and lack of knowledge of the good evidence behind its practice. In contrast, a few respondents whose programs did not provide any training on ART raised logistical challenges that limit the use of ART in predoctoral pediatric dentistry clinics. One important challenge was that, at some institutions, decisions regarding product ordering and utilization are not controlled by the departments. Thus, access to materials needed for ART may not be available for predoctoral students.

The distribution of these program directors’ attitudes toward ART was skewed towards a more positive attitude: only one program director scored less than 30 on the scale, and seventeen program directors scored between 40 and 50. However, twenty-three program directors out of forty-four scored between 30 and 40 on the attitude scale, which indicates that most of the program directors were more neutral towards ART. Similarly, other U.S. national studies^{13,32} in 2006 and 2009 found relatively more positive attitudes towards ART among civilian, federal, and public health dentists.

A strong predictor for the program directors’ attitudes toward ART in our study was the belief that professional guidelines are very important factors in the selection of restorative treatment modalities. In surveys of pediatric and general dentists, professional guidelines have been rated as an important factor in selecting treatment modalities.^{32,33} Although the AAPD guidelines give ART another name and endorse it only as interim restoration, this association encourages its use with very young, uncooperative, and high caries risk children.¹³ Additionally, program directors in our study who strongly disagreed with the statement “definitive restorations should be the treatment of choice regardless of other factors” had

more positive attitudes towards ART. Although the trend in the United States has been toward definitive restorations as the treatment of choice,^{15,32,33} many dental practitioners have started to believe in less invasive procedures,^{16,34} especially in pediatric dentistry where managing the behavior of the child while performing traditional definitive treatments is always a challenge.

While this study was the first of its kind in assessing predoctoral training on ART in the United States, it did have some limitations. One limitation was the small size of the population. Although we had a high response rate of 77 percent, the number of dental schools accredited by the ADA in 2010 (fifty-seven dental schools) posed some difficulties in statistical analysis. Another limitation of this study was the difficulty to get a sampling frame for our population. There is no list available at the AAPD or ADEA for predoctoral pediatric dentistry program directors, and the position may not exist in some dental schools. In such cases, it was up to the department chair to answer the questions or forward them to another faculty member. In addition, caries management in some dental schools may be shared between operative/restorative dentistry and pediatric dentistry, so some aspects of training may have been missed in this survey of predoctoral pediatric dentistry programs. However, the focus of our study was on child restorative treatment options, so we consider our results to be valid to answer this question.

Conclusion

Research has demonstrated that the ART approach produces quality restorations in single-surfaces in both primary and permanent teeth using high viscosity glass ionomers. ART with its low cost and atraumatic nature can be a means to alleviate the problem of access to dental care among underserved populations worldwide. To prompt more dental practitioners to accept, adopt, and apply ART, dental schools should emphasize the evidence behind ART and teach the philosophy, technique, and correct use of ART. Equally important, the right instruments and the correct materials should be sufficiently available in predoctoral pediatric dentistry clinics to support programs to use ART.

Our study found that 66 percent of the responding predoctoral pediatric dentistry programs in the United States provided clinical training on ART. However, only 14 percent of those programs used

ART very often or often as a caries management technique for their pediatric patients. The responding predoctoral pediatric dentistry programs reported using ART mainly in primary, anterior, and single-surface cavities and as interim treatment.

The importance of professional guidelines as a factor in selecting treatment options explained 41 percent of variation in the attitudes toward ART of these program directors and 27 percent of the variation in the level of clinical training on ART provided to predoctoral students. Consequently, to facilitate the incorporation of ART technique into dental schools' curricula, professional organizations should endorse the use of ART as a well-documented alternative caries management technique that may effectively serve the needs of certain populations and improve their access to dental care and quality of oral health.

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REFERENCES

1. World Health Organization Division of Noncommunicable Diseases, Oral Health Program. Atraumatic restorative treatment (ART) for tooth decay: a global initiative, 1998-2000. Geneva: World Health Organization, 1998.
2. Carvalho TS, Ribeiro TR, Bönecker M, Pinheiro ECM, Colares V. The atraumatic restorative treatment approach: an "atraumatic" alternative. *Med Oral Patol Oral Cir Bucal* 2009;14:668-73.
3. Schriks MC, van Amerongen WE. Atraumatic perspectives of ART: psychological and physiological aspects of treatment with and without rotary instruments. *Community Dent Oral Epidemiol* 2003;31:15-20.
4. Honkala S, Honkala E. Atraumatic dental treatment among Finnish elderly persons. *J Oral Rehabil* 2002;29:435-40.
5. Mjör IA, Gordan VV. A review of atraumatic restorative treatment (ART). *Int Dent J* 1999;49:127-31.
6. Pilot T. Introduction: ART from a global perspective. *Community Dent Oral Epidemiol* 1999;27:421-2.
7. Estupinan-Day S, Milner T, Tellez M. Oral health of low-income children: procedures for atraumatic restorative treatment. Final report. Washington, DC: Pan American Health Organization, 2006.
8. Mickenautsch S, Yengopal V, Banerjee A. Atraumatic restorative treatment versus amalgam restoration longevity: a systematic review. *Clin Oral Invest* 2010;14:233-4.
9. Frencken JE, Taifour D, van't Hof MA. Survival of ART and amalgam restorations in permanent teeth of children after 6.3 years. *J Dent Res* 2006;85(7):622-6.
10. Frencken JE, van't Hof MA, Taifour D, Al-Zaher I. Effectiveness of ART and traditional amalgam approach in restoring single-surface cavities in posterior teeth of permanent dentitions in school children after 6.3 years. *Community Dent Oral Epidemiol* 2007;35(3):207-14.

11. De Amorim R, Leal SC, Frencken JE. Survival of atraumatic restorative treatment (ART) sealants and restorations: a meta-analysis. *Clin Oral Investig* 2012;16(2):429-41.
12. Van't Hof MA, Frencken JE, van Palenstein Helderman WH, Holmgren CJ. The atraumatic restorative treatment (ART) approach for managing dental caries: a meta-analysis. *Int Dent J* 2006;56:345-51.
13. American Academy of Pediatric Dentistry. Policy on interim therapeutic treatment. Chicago: American Academy of Pediatric Dentistry, 2010.
14. U.S. Health Resources and Services Administration, Indian Health Service. Promoting and enhancing the oral health of the public: early childhood caries initiative. At: www.hrsa.gov/publichealth/clinical/oralhealth/hhsinitiative.pdf. Accessed: May 1, 2012.
15. Gaskin EB, Levy S, Guzman-Armstrong S, Dawson D, Chalmers J. Knowledge, attitudes, and behaviors of federal service and civilian dentists concerning minimal intervention dentistry. *Mil Med* 2010;175(2):115.
16. Seale S, Casamassimo P. Access to dental care for children in the United States: a survey of general practitioners. *J Am Dent Assoc* 2003;134(12):1630-40.
17. Autio-Gold J, Tomar S. Dental students' opinions and knowledge about caries management and prevention. *J Dent Educ* 2008;72(1):26-32.
18. Rich JP III, Straffon L, Inglehart MR. General dentists and pediatric dental patients: the role of dental education. *J Dent Educ* 2006;70(12):1308-15.
19. Cotton KT, Seale NS, Kanellis MJ, Damiano PC, Bidaut-Russell M, McWhorter MG. Are general dentists' practice patterns and attitudes about treating Medicaid-enrolled preschool age children related to dental school training? *Pediatr Dent* 2001;23(1):51-5.
20. Seale NS, McWhorter AG, Mouradian WE. Dental education's role in improving children's oral health and access to care. *Acad Pediatr* 2009;9(6):440-5.
21. Frencken JE, Pilot T, Songpaisan Y, Phantumvanit P. Atraumatic restorative treatment (ART): rationale, technique, and development. *J Public Health Dent* 1996;56(3 Spec No):135-40,161-3.
22. PASW Statistics. Version 18.0.0. Chicago: SPSS Inc., 2010.
23. Mickenautsch S, van't Hof MA, Frencken JE. Oral health service systems in Gauteng Province, South Africa. *East Afr Med J* 2007;84 (4):178-82.
24. Ruiz O, Frencken JE. ART integration in oral health care systems in Latin American countries as perceived by directors of oral health. *J Appl Oral Sci* 2009;17(Suppl):106-13.
25. Schulte AG, Buchalla W, Huysmans MC, Amaechi BT, Sampaio F, Vougiouklakis G, Pitts NB. A survey on education in cariology for undergraduate dental students in Europe. *Eur J Dent Educ* 2011;15(Suppl 1):3-8.
26. American Dental Education Association. 2010 ADEA official guide to dental schools. Washington, DC: American Dental Education Association, 2010.
27. Fukai K, Ohno H, Blinkhorn AS. A cross-sectional survey investigating the care of the primary dentition by general dental practitioners working in Japan and England. *Int Dent J* 2010;60(6):389-94.
28. Kateeb E, Warren JJ, Momany E, Kanellis M, Damiano PC, Weber-Gasparoni K, Ansley T. Clinical training on ART in pediatric dentistry residency programs. *J Pediatr Dent*, forthcoming.
29. American Academy of Pediatric Dentistry. Policy on interim therapeutic treatment. Chicago: American Academy of Pediatric Dentistry, 2001.
30. Mickenautsch S, Rudolph MJ, Ogunbodede EO, Frencken JE. The impact of the ART approach on the treatment profile in a mobile dental system (MDS) in South Africa. *Int Dent J* 1999;49(3):132-8.
31. Spott TH. Discriminating factors in faculty use of instructional technology in higher education. *Educ Technol Society* 1999;2(4).
32. Seale NS, Kendrick A. Management of caries in the child three years of age and younger: a survey of post-doctoral pediatric dentistry program directors. *Pediatr Dent* 2002;24(1):33-7.
33. Seale NS, Kendrick AG. A survey of pediatric dentists' management of dental caries in children three years of age or younger. *Pediatr Dent* 2001;23(3):211-6.
34. Oliveira DC. Minimally invasive dentistry approach in dental public health. Master's thesis, University of Iowa, 2011.