Factors related to the use of atraumatic restorative treatment (ART) in pre and post-pediatric dentistry programs and in pediatric dentistry practices in the US

Elham Talib Kateeb

University of Iowa

Copyright 2012 Elham T. Kateeb

This dissertation is available at Iowa Research Online: https://ir.uiowa.edu/etd/2912

Recommended Citation
Kateeb, Elham Talib. "Factors related to the use of atraumatic restorative treatment (ART) in pre and post-pediatric dentistry programs and in pediatric dentistry practices in the US." PhD (Doctor of Philosophy) thesis, University of Iowa, 2012. https://doi.org/10.17077/etd.3nxt74eq

Follow this and additional works at: https://ir.uiowa.edu/etd

Part of the Oral Biology and Oral Pathology Commons
FACTORS RELATED TO THE USE OF ATRAUMATIC RESTORATIVE TREATMENT (ART) IN PRE AND POST-PEDIATRIC DENTISTRY PROGRAMS AND IN PEDIATRIC DENTISTRY PRACTICES IN THE US

by

Elham Talib Kateeb

An Abstract

Of a thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Oral Science in the Graduate College of The University of Iowa

May 2012

Thesis Supervisor: Professor John Warren
ABSTRACT

Dental Caries is still considered one of the most prevalent chronic diseases that affect children in the US. Access to oral care problems could be due to the limited availability of services or unwillingness of people to seek services. As a proposed solution to those challenges, Atraumatic Restorative Technique (ART) was developed in the 1980s as an affordable, patient friendly caries management procedure that does not need extensive operator training or special skills. ART was originally developed to be conducted in field settings; however, after initial evidence of effectiveness, the World Health Organization (WHO) and the International Dental Federation (FDI) promoted the use of ART in modern clinical settings worldwide. In the US, the practice of ART is not believed to be widely used. This may be a result of little attention given to (ART) in dental education and advanced training.

This dissertation is comprised of three separate studies that investigated the extent and the factors related to the didactic and clinical instruction on ART in US pre- and post-doctoral pediatric dentistry programs and the factors related to the willingness of pediatric dentists to use ART with their child patients.

In study I and II, the same instrument was used (with only minor modifications) to survey post-doctoral pediatric dentistry program directors and pre-doctoral pediatric dentistry program directors. In study III a different instrument was used to survey pediatric dentists in the US. The survey instruments were tested for content and face validity by cognitive analysis interviews and pilot testing.

Using web-based survey methodology, two questionnaires were sent out in May 2010 to investigate self-reported use of ART in educational training institutes (study I and II) and in April 2011, a third questionnaire was sent to a random national sample of pediatric dentists (study III). Using a conjoint design, the third questionnaire asked pediatric dentists to rate their willingness to use ART for 9 patients’ scenarios.
Eighty eight percent of Pediatric Dentistry Residency programs and 66% of pre-doctoral pediatric dentistry programs in the US provided clinical training on ART; however only 30% of post-doctoral programs and 14% of pre-doctoral programs used ART “Very Often/ Often” as a caries management technique for their pediatric patients. Pediatric Dentistry residency programs and pre-doctoral pediatric dentistry programs used ART mainly in primary, anterior, single surface cavities and as an interim treatment. Attitudes toward ART alone and after controlling for other variables explained 35% of the level of training on ART in post-doctoral program and 23% in pre-doctoral pediatric dentistry programs. For study III, conjoint analysis showed that being very young and/or uncooperative were the most important reasons practitioners reported a higher likelihood of using ART. Although insurance coverage was the least important factor overall, not having any insurance was identified as an additional important factor in decisions to use ART.

Collectively, our results suggest that that the use of ART is not widespread in the US. In addition, ART is viewed by some as a sub optimum treatment and needs to be modified to conform to the US standards of care. On the other hand, educators and pediatric dentists who had positive views of ART thought it could be a valuable treatment for very young, uncooperative children and children with no insurance.

Abstract Approved:

________________________________
Thesis Supervisor

________________________________
Title and Department

________________________________
Date
FACTORS RELATED TO THE USE OF ATRAUMATIC RESTORATIVE TREATMENT (ART) IN PRE AND POST-PEDIATRIC DENTISTRY PROGRAMS AND IN PEDIATRIC DENTISTRY PRACTICES IN THE US

by

Elham Talib Kateeb

A thesis submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Oral Science in the Graduate College of The University of Iowa

May 2012

Thesis Supervisor: Professor John Warren
Graduate College
The University of Iowa
Iowa City, Iowa

CERTIFICATE OF APPROVAL

____________________________________
PH.D. THESIS

This is to certify that the Ph.D. thesis of

Elham Talib Kateeb

has been approved by the Examining Committee
for the thesis requirement for the Doctor of Philosophy
degree in Oral Science at the May 2012 graduation.

Thesis Committee: ____________________________
John Warren, Thesis Supervisor

____________________________________
Peter Damiano

____________________________________
Elizabeth Momany

____________________________________
Michael Kanellis

____________________________________
Karin Weber-Gasparoni

____________________________________
Tim Ansley

____________________________________
Gary Gaeth
ACKNOWLEDGMENTS

This dissertation holds far more than the culmination of years of study. These pages also reflect the relationships with many generous and inspiring people I have met since beginning my graduate work at the University of Iowa. The list is long, but I cherish each contribution to my development and growth as a researcher and a public health dentist:

To my advisor John Warren for his guidance, understanding, patience, flexibility, genuine caring and concern and most importantly, his encouragement not only to grow as a researcher but also as an independent thinker.

To my committee members, Gary Gaeth, Elizabeth Momany, Peter Damiano, Mickel Kanellis, Karin Weber-Gasparoni and Tim Ansley for their encouraging words, thoughtful criticism, valuable input, and time and attention during busy semesters.

To all my professors through my academic work, especially, Steve Levy, Ray Kuthy, and Dan Caplan for showing me by example and through challenging coursework how to think, critique, and apply what I learn in real life situations.

To Professor Jo Frencken at the Global Oral Health Department, University of Nijmegen, for providing me with the vision and advice necessary to start my dissertation topic and proceed through the doctoral program.

To all my colleagues in Dental Public Health, Oral Science and Operative Dentistry for sharing their enthusiasm for my work, helpful discussion, comments and continuing support.

To all the individuals and/or agencies for their financial support that enabled me to complete my doctoral coursework and dissertation at the University of Iowa: Dr. Christopher Squier (NIH/NIDCR NRSA Institutional Oral Health Research Training Grant T32); Dr. Steven Levy (HRSA Dental Public Health Specialty Training Grant) and Al Quds University, East Jerusalem.
To my invaluable network of supportive, forgiving, generous and loving friends, especially Mudar and Jumana, without whom I could not have survived the process.

To my extended family, for their constant source of love, concern, support and strength all these years, my brothers, sisters, nieces, nephews and in-laws.

To my parents, for their love, care support and continuous prayers for me the long years of my education: Talib El Khatib and Naima Khalf.

And finally, to my immediate family for their support, encouragement, quiet patience and unwavering love were undeniably the bedrock upon which the past ten years of my life have been built, my husband, Rafat, and my two sons, Sami and Saif; nothing in a simple paragraph can express the love I have for the three of you.
ABSTRACT

Dental Caries is still considered one of the most prevalent chronic diseases that affect children in the US. Access to oral care problems could be due to the limited availability of services or unwillingness of people to seek services. As a proposed solution to those challenges, Atraumatic Restorative Technique (ART) was developed in the 1980s as an affordable, patient friendly caries management procedure that does not need extensive operator training or special skills. ART was originally developed to be conducted in field settings; however, after initial evidence of effectiveness, the World Health Organization (WHO) and the International Dental Federation (FDI) promoted the use of ART in modern clinical settings worldwide. In the US, the practice of ART is not believed to be widely used. This may be a result of little attention given to (ART) in dental education and advanced training.

This dissertation is comprised of three separate studies that investigated the extent and the factors related to the didactic and clinical instruction on ART in US pre- and post-doctoral pediatric dentistry programs and the factors related to the willingness of pediatric dentists to use ART with their child patients.

In study I and II, the same instrument was used (with only minor modifications) to survey post-doctoral pediatric dentistry program directors and pre-doctoral pediatric dentistry program directors. In study III a different instrument was used to survey pediatric dentists in the US. The survey instruments were tested for content and face validity by cognitive analysis interviews and pilot testing.

Using web-based survey methodology, two questionnaires were sent out in May 2010 to investigate self-reported use of ART in educational training institutes (study I and II) and in April 2011, a third questionnaire was sent to a random national sample of pediatric dentists (study III). Using a conjoint design, the third questionnaire asked pediatric dentists to rate their willingness to use ART for 9 patients’ scenarios.
Eighty eight percent of Pediatric Dentistry Residency programs and 66 % of pre-doctoral pediatric dentistry programs in the US provided clinical training on ART; however only 30% of post-doctoral programs and 14 % of pre-doctoral programs used ART “Very Often/ Often” as a caries management technique for their pediatric patients. Pediatric Dentistry residency programs and pre-doctoral pediatric dentistry programs used ART mainly in primary, anterior, single surface cavities and as an interim treatment. Attitudes toward ART alone and after controlling for other variables explained 35% of the level of training on ART in post- doctoral program and 23% in pre-doctoral pediatric dentistry programs. For study III, conjoint analysis showed that being very young and/or uncooperative were the most important reasons practitioners reported a higher likelihood of using ART. Although insurance coverage was the least important factor overall, not having any insurance was identified as an additional important factor in decisions to use ART.

Collectively, our results suggest that that the use of ART is not widespread in the US. In addition, ART is viewed by some as a sub optimum treatment and needs to be modified to conform to the US standards of care. On the other hand, educators and pediatric dentists who had positive views of ART thought it could be a valuable treatment for very young, uncooperative children and children with no insurance.
# TABLE OF CONTENTS

LIST OF TABLES ........................................................................................................................................................................... ix
LIST OF FIGURES ............................................................................................................................................................................... xi

## CHAPTER 1: INTRODUCTION ............................................................................................................................... 1

## CHAPTER 2: REVIEW OF THE LITERATURE ..................................................................................................... 4

- Dental caries as an oral health problem and its consequences on oral health care system .................................................. 4
- Dental caries among children in the US ............................................................................................................................. 4
- Utilization of dental care service ....................................................................................................................................... 5
- Availability of services ............................................................................................................................................................. 6
- Financing dental care ............................................................................................................................................................... 7
- Approaches to control dental caries among children ........................................................................................................... 8
  - Preventive therapies ............................................................................................................................................................ 8
  - Restorative therapies ......................................................................................................................................................... 9
- Caries stabilization techniques ................................................................................................................................................. 9
  - Classical strategies ................................................................................................................................................................ 9
  - Alternative strategies .......................................................................................................................................................... 10
- Minimal invasive Intervention ............................................................................................................................................... 10
- The concept of ART ............................................................................................................................................................... 11
- ART in field studies .............................................................................................................................................................. 12
- ART in standard dental clinics ............................................................................................................................................... 14
- ART as a less traumatic restorative treatment alternative .............................................................................................. 16
- Cost effectiveness of ART ................................................................................................................................................... 19
- The use of ART in the US .................................................................................................................................................... 20
- Barriers to adopt new restorative techniques in dental practice and dental training programs ........................................... 23
- The role of dental education in the formation of attitudes and behavior of dentists towards different caries managing techniques .................................................................................................................. 26
- Aims of this project .............................................................................................................................................................. 33

## CHAPTER 3: THE GENERAL METHODS ........................................................................................................ 35

- Introduction ................................................................................................................................................................. 35
- General research perspective ............................................................................................................................................. 35
- Participants ..................................................................................................................................................................... 36
- Representativeness of the sampling frame ...................................................................................................................... 36
- Materials for study I and II ............................................................................................................................................... 36
- Description of the survey instrument for study I and II ................................................................................................. 37
- Independent variables in study I and II .......................................................................................................................... 37
- The composite variable, the use of MID techniques used in study I and II ........................................................................ 37
- The composite variable regarding Program directors’ attitude towards ART that was used in studies I and II ................................................................................................................................................ 38
- Dependent variables in study I and II ............................................................................................................................. 38
- Materials for study III ..................................................................................................................................................... 39
- Study survey instrument in study III ............................................................................................................................ 39
- Conjoint questions .......................................................................................................................................................... 40
- Independent variables in study III ................................................................................................................................... 40
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable in study III</td>
<td>40</td>
</tr>
<tr>
<td>Conjoint design</td>
<td>40</td>
</tr>
<tr>
<td>Data Management in study I, II and III</td>
<td>40</td>
</tr>
<tr>
<td>Statistical analysis in study I, II and III</td>
<td>41</td>
</tr>
<tr>
<td>CHAPTER 4 ATRAUMATIC RESTORATIVE TREATMENT (ART) IN PEDIATRIC DENTISTRY RESIDENCY PROGRAMS: A SURVEY OF PROGRAM DIRECTORS</td>
<td>43</td>
</tr>
<tr>
<td>Abstract</td>
<td>43</td>
</tr>
<tr>
<td>Introduction</td>
<td>43</td>
</tr>
<tr>
<td>Methods</td>
<td>47</td>
</tr>
<tr>
<td>Data Management</td>
<td>49</td>
</tr>
<tr>
<td>Statistical analysis</td>
<td>50</td>
</tr>
<tr>
<td>Results</td>
<td>51</td>
</tr>
<tr>
<td>Program Directors’ Characteristics</td>
<td>51</td>
</tr>
<tr>
<td>Program Characteristics</td>
<td>51</td>
</tr>
<tr>
<td>Patient population served by the program characteristics</td>
<td>52</td>
</tr>
<tr>
<td>Attitude of Program Directors towards ART</td>
<td>52</td>
</tr>
<tr>
<td>Didactic Instruction Provided On ART</td>
<td>53</td>
</tr>
<tr>
<td>Level of Clinical Training Provided on ART</td>
<td>54</td>
</tr>
<tr>
<td>Discussion</td>
<td>55</td>
</tr>
<tr>
<td>Conclusions</td>
<td>62</td>
</tr>
<tr>
<td>CHAPTER 5 DOES ATRAUMATIC RESTORATIVE TREATMENT (ART) HAVE A PLACE IN THE US DENTAL SCHOOLS’ CURRICULA? A SURVEY OF PRE-DOCTORAL PEDIATRIC DENTISTRY PROGRAMS</td>
<td>74</td>
</tr>
<tr>
<td>Abstract</td>
<td>74</td>
</tr>
<tr>
<td>Introduction</td>
<td>74</td>
</tr>
<tr>
<td>Methods</td>
<td>76</td>
</tr>
<tr>
<td>Statistical analysis</td>
<td>79</td>
</tr>
<tr>
<td>Results</td>
<td>80</td>
</tr>
<tr>
<td>Discussion</td>
<td>84</td>
</tr>
<tr>
<td>Conclusions</td>
<td>90</td>
</tr>
<tr>
<td>CHAPTER 6 THE WILLINGNESS OF US PEDIATRIC DENTISTS TO USE ATRAUMATIC RESTORATIVE TREATMENT (ART) WITH THEIR PATIENTS: A CONJOINT ANALYSIS</td>
<td>102</td>
</tr>
<tr>
<td>Abstract</td>
<td>102</td>
</tr>
<tr>
<td>Introduction</td>
<td>103</td>
</tr>
<tr>
<td>Method</td>
<td>106</td>
</tr>
<tr>
<td>Conjoint questions</td>
<td>107</td>
</tr>
<tr>
<td>Conjoint design</td>
<td>109</td>
</tr>
<tr>
<td>Data Management</td>
<td>110</td>
</tr>
<tr>
<td>Data analysis</td>
<td>110</td>
</tr>
<tr>
<td>Results</td>
<td>112</td>
</tr>
<tr>
<td>Sample characteristics</td>
<td>112</td>
</tr>
<tr>
<td>The pattern of ART use in this sample</td>
<td>113</td>
</tr>
<tr>
<td>Conjoint questions</td>
<td>113</td>
</tr>
<tr>
<td>Response bias</td>
<td>115</td>
</tr>
</tbody>
</table>
Respondents who showed no variation in their rating of patients’
profiles ................................................................. 115
Discussion ........................................................................ 116
Conclusion ........................................................................ 122

CHAPTER 7: DISCUSSION .................................................................................. 135

Introduction ......................................................................................... 135
Clinical training on ART in pre and post-doctoral pediatric dentistry
programs (Studies I and II) ................................................................. 136
Didactic instruction on ART in pre and post-doctoral pediatric dentistry
programs (Studies I and II) ................................................................. 137
Attitude of program directors towards ART ................................. 137
Factors that influenced the decision of pediatric dentists to use ART in
anterior primary teeth (Study III) ....................................................... 137
General discussion ........................................................................... 138
Study implications ........................................................................... 140

CHAPTER 8: CONCLUSIONS ............................................................................. 143

Introduction ......................................................................................... 143
Summary of the results of the three studies .................................... 143
General conclusion ........................................................................... 145

APPENDIX .................................................................................................. 146

REFERENCES ............................................................................................. 163
LIST OF TABLES

Table 1  Distribution of Responses to Questions Regarding Frequency of Use of Selected MID Procedures among Pediatric Dentistry Residents ..........64

Table 2  Distribution of Responses to Questions Regarding Agreement or Disagreement to 10 Statements that described Attitude of Program Directors towards ART ..................................................65

Table 3  Respondents Pediatric Dentistry Programs directors’ characteristics ..........66

Table 4  Results of Bivariate analysis Using Spearman Rank Correlation test of the Attitude of Program Directors towards ART Composite Variable and Selected Predictor Variables .................................................67

Table 5  Results of Multiple Linear Regression of the Attitude of Program Directors towards ART Composite Variable ..................................................68

Table 6  Results of Bivariate analysis of the Variable Didactic Instruction on ART Provided to Residents in Pediatric Dentistry Residency Programs and Selected Independent variables .................................................................69

Table 7  Results of Logistic Regression of the Variable Didactic Instruction on ART Provided to Residents in Pediatric Dentistry Residency Programs. ......70

Table 8  Results of The frequency of Use of Different Types of ART in Pediatric Dentistry Residency Programs ..................................................71

Table 9  Results of Bivariate analysis Using Spearman Rank Correlation Test of the Variable Clinical Training on ART Provided to Residents in Pediatric Dentistry Residency Programs and Selected Independent variables .................................................................72

Table 10 Results of Multiple Linear Regression of the Variable Clinical Training on ART Provided to Residents in Pediatric Dentistry Residency Programs ..................................................73

Table 11 Distribution of Responses to Questions Regarding Frequency of Use of Selected MID Procedures in Pre-doctoral Pediatric Dentistry training ..........92

Table 12 Distribution of Responses to Questions Regarding Agreement or Disagreement to 9 Statements that described Attitude of Pediatric Dentistry Program directors towards ART ..................................................93

Table 13 Results of The frequency of Use of Different Types of ART in Pre-doctoral Pediatric Dentistry clinical training ..................................................94

Table 14 Results of Bivariate Analysis of the Variable Clinical Training on ART Provided in Pre-doctoral Pediatric Dentistry Clinical Training and Selected Independent variables .................................................................95

Table 15 Results of Multiple Linear Regression of the Variable Clinical Training on ART Provided in Pre-doctoral Pediatric Dentistry clinical training ..........96
Table 16  Results of Bivariate analysis of the Variable Didactic Instruction on ART Provided to Dental students in Pediatric Dentistry curriculum and Selected Independent variables and the Results of the Logistic Regression of the Variable Didactic Instruction on ART. .................................................................97

Table 17  Results of Bivariate analysis Using Spearman Rank Correlation test of the Attitude of Program Directors towards ART Composite Variable and Selected Predictor Variables and the Results of the Multiple Linear Regression of the Attitude of Program directors towards ART .................98

Table 18  Respondents Pre-doctoral Pediatric Dentistry Program directors’ Characteristics...........................................................................................................99

Table 19  Respondents Pre-doctoral Pediatric Dentistry Programs’ Characteristics ....100

Table 20  Characteristics of patient population served by the pre-doctoral pediatric dentistry program ..................................................................................................................101

Table 21  Demographic and practice characteristics of the original sample of the 723 pediatric dentists who submitted the online survey .................................126

Table 22  Factors influenced pediatric dentists’ use of ART as definitive or interim treatment in primary teeth .................................................................................................127

Table 23  Sources of knowledge about ART among our sample of 723 pediatric dentists (check all that apply format) ....................................................................................................128

Table 24  Examples of Patient Scenarios, the Total Utility, Maximum Utility and Logit Values of Selected Patients’ Scenarios.................................................................131

Table 25  A comparison between non-traders and traders, the original sample and the whole AAPD list by demographic and practice characteristics ..........132

Table 26  A comparison between non-traders who were not willing to use ART with any of the scenarios and column A, the non-traders who were willing to use ART with all the scenarios and column B, the traders who were willing to use ART at different levels ........................................133

Table 27  The differences in factors influencing pediatric dentists’ decision to use ART as definitive or interim treatment between the two subsets of the non-traders; the ones who were not willing to use ART with any of the scenarios and the ones who were willing to use ART with all the scenarios ..............................................................................134
LIST OF FIGURES

Figure 1 Conceptual Model of Study I .................................................................62
Figure 2 Conceptual Model of Study II ...............................................................90
Figure 3 Step by step sampling procedure for Study III .........................................122
Figure 4 The conceptual model of our conjoint study including the three factors and their levels.................................................................123
Figure 5 Steps in constructing the conjoint design for this study adapted from ISPOR ..................................................................................124
Figure 6 Results of utility estimates of the levels of the three factors, Age, Cooperation level and Insurance coverage and the importance values of each factor.................................................................128
Figure 7 The confidence intervals (CI) of the factors’ levels’ utility estimates. ........129
CHAPTER 1: INTRODUCTION

Dental Caries is still considered one of the most prevalent chronic diseases that affect children in the US. It is five times more common than asthma and seven times more prevalent than hay fever. Although Dental Caries levels have showed marked decline in the last thirty years, certain groups within the US population still suffer from high levels of the disease. This could be due to the limited access to preventive care and oral health treatment. These vulnerable populations include children in general, and children from low income and minority families, in particular.

Since the Surgeon General’s report, Oral Health in America 2000, which pointed out the dental caries disparities especially among children, dental and public health communities have been looking for individual and population-based solutions for this problem. Avenues such as fluoride application, diet modification and oral health education have showed promising results in alleviating some of the dental disease burden; however access to dental care, including preventive and treatment services, is still a challenge.

Access to care problems could be due to the limited availability of services or unwillingness of people to seek services. Limited availability of services could be due to Lack of special training of dentists to treat children; reluctance of dentists to treat children with Medicaid coverage or uninsured children, or limited availability of community centers that usually accept Medicaid children or others at reduced fees. Unwillingness of people to seek services could be due to the high costs of treatments, lack of awareness and motivation, or due to behavioral problems among children such as fear and anxiety about dental procedures.

One possible solution for these challenges is to look for more affordable, patient friendly caries management procedures that do not need extensive operator training or special skills. One proposed technique is Atraumatic Restorative Treatment (ART).
ART was developed in Tanzania in the mid-1980s as a method to provide dental care in rural areas and for underserved populations. ART was originally developed to be conducted in field settings and currently the World Health Organization (WHO) promotes the use of ART especially with children. ART uses hand instruments to remove decayed diseased tissues from usually small lesions of the teeth and restores these cavities with a dental caries stabilization dressing, usually GLass Ionomer (GI) products. Injections and rotary instruments are usually unnecessary with the ART technique.

ART was introduced for the first time in a clinical setting in the 1990s and now many practitioners throughout the world use ART as a treatment modality for managing dental caries in children. Dentists around the world view ART as an alternative treatment to sending anxious or uncooperative children to an operating room for treatment. They also consider ART as an affordable option for parents who can’t afford to pay for more sophisticated treatments, particularly in communities without dental insurance coverage. Therefore, it is believed that the use of ART technique for treatment of children might help facilitate future restorative, preventive and psychological care by allowing the child to overcome his or her fears of traditional dental treatment.

Furthermore, ART is in harmony with modern concepts of dental tissue preservation. ART is based on the maximum preservation of sound tooth tissue and the minimum feeling of discomfort and pain. In addition, the concept of stabilizing caries, such as ART, is consistent with the new approaches of targeting dental caries as a disease. This new shift in dental caries management philosophy approaches dental caries as a disease that needs to be assessed for its risk and activity, rather than treating the symptoms only by filling and crowning the teeth. According to this new philosophy, lowering risk and minimizing disease activity are the goals of dental treatment. Thus the use of ART among children with high disease activity enables practitioners to stabilize the disease while working on other aspects of it, such as suppressing the bacteria; limiting
the substrate upon which they survive; enhancing the oral environment by increasing saliva and its minerals; and protecting the teeth with fluoride and sealants.

The American Academy of Pediatric Dentistry (AAPD) considers ART as an interim tooth decay stabilization method in children with multiple cavitated lesions. However, the practice of ART in the United States is limited and sometimes considered as less than optimum treatment. This attitude could be a result of inadequate knowledge of ART: its purpose, technique or success rates. This lack of knowledge could also be a result of little attention given to ART training in pre and post-doctoral pediatric dentistry curricula among US dental schools.

This study aims to understand one of the barriers to using dental caries stabilization methods, such as ART, in modern dentistry in the US. This will be achieved by 1) surveying pediatric dentists in academic settings about their attitude towards ART and how much knowledge and training they provide their pre and post-doctoral students about the use of ART with pediatric patients, 2) surveying pediatric dentists about the factors that influence their decision to use ART with their pediatric patients.

By studying this, barriers can be identified and better efforts made to promote alternative approaches to oral care for underserved populations, especially children.
CHAPTER 2: REVIEW OF THE LITERATURE

Dental caries as an oral health problem and its consequences on oral health care system

Dental caries is one of the most common preventable childhood diseases; however, people are prone to the disease throughout their lifetimes. It is the primary cause of oral pain and tooth loss. It can be arrested and potentially reversed in its early stages, but is often not self-limiting and without appropriate care, caries can advance until the tooth is destroyed.

There are substantial monetary costs for dental caries in children. The cost to treat early childhood caries varies from $1,000 and $2,000 and up to $6,000 if general anesthesia in the operating room is required. Dental caries in children may also have a long-term effect on the child because caries in the primary teeth is the biggest risk factor for caries in permanent teeth. In addition, children with high caries levels are more likely to experience problems with their physical development, school attendance, and increased days with restricted activity. They may also correlate with diminished ability to learn.

Dental caries among children in the US

After the steep decline of dental caries prevalence in the 1980s, many in the health community thought that dental caries would become a disease of the past. However the results of 1999-2004 national survey revealed striking news when it showed that dental caries is still a prevalent disease in all age groups, despite the overall decline. Even more surprising, were the data that demonstrated the dental decay levels among children aged 2-4 which were higher than the previous survey. Specifically, the Mid Course Revision of Healthy People 2010 objectives showed that among young children aged 2 to 4 years, the prevalence of dental caries in primary teeth increased from
18% in 1988–1994 to 24% in 1999–2004. Thus, in comparison with older children, caries in preschool children increased significantly over the past decade.\textsuperscript{13}

What makes this problem more complicated are the disparities in disease distribution. “Disparity in young children's oral health tells a story of the most vulnerable of the vulnerable. As a group, young children constitute a vulnerable population because of their dependence, their inability to communicate needs, and their relative poverty.”\textsuperscript{14} In children, 80% of the disease burden is carried by 25% of the population. National Surveys and other research found that minorities and low-income populations suffer from higher levels of the disease compared to the white affluent children.\textsuperscript{14} This oral health disparity suggests that systemic factors other than biological factors play an important role in putting those children at risk. Access to fluoride, level of parents’ education, socioeconomic class, awareness of the oral health problems, availability of preventive services and access to care were among the identified systemic risk factors for dental caries among children.\textsuperscript{15}

This may indicate a two way problem: the failing of the system to meet the needs of those populations and the unwillingness of those families to seek oral health care for their children.

\textbf{Utilization of dental care services}

In a study,\textsuperscript{16} investigated the factors related to the utilization of dental care by 5- to 11-year-old children from low-income households, a comprehensive multivariate model that assessed the contribution of structure, history, cognition, and expectations was used. The influence of dentist-patient interactions, and psychosocial and health beliefs, particularly fear of the dentist, on utilization were also investigated. Children were chosen randomly from public schools, and 895 mothers were surveyed and their children were interviewed at home. Utilization was studied during the 1991-1992 school year, including a 6-month follow-up period after the interview.\textsuperscript{16} The overall utilization rate was 63.2%, and the rate for non-emergent (preventive) visits was 59.9%; utilization was unrelated to actual oral
health status. Race and years the guardian lived in the United States were predictive of an episode of care. Preventive medical visits and perceived need were strong predictors of a visit to the dentist, as were beliefs in the efficacy of dental care. Mothers who were satisfied with their own care and oral health and whose children were covered by insurance were more likely to utilize children's dental care. In contrast, child dental fear and absences from school were associated with lower rates of utilization. This study identified factors related to the system and to the people themselves that govern the use of care in the population understudy.

**Availability of services**

Of the 22 oral health objectives enumerated in the U.S. Department of Health and Human Services document Healthy People 2010, the great majority is directly related to enhancing access to dental care or requires enhanced access to be successfully accomplished. The so-called dental “safety net”—composed of federally qualified health centers, other health centers, hospital outpatient dental clinics and training programs, and dental school clinics—serve to adjunct the private practice dental care system that provides most of the dental care in the United States. The capacity of the safety net settings to treat underserved groups is limited, and they are forced in many cases to rely on revenues from groups that are not underserved for their financial survival.

Private sector financing typically separates medical and dental coverage, but at least conceptually the Medicaid EPSDT benefit covers dental and medical services together as part of comprehensive health care. Most State Children’s Health Insurance Program (SCHIP) plans also provide dental coverage for near poor children, although the design of the dental benefit is left to the decision of states. However, children in near poor and working poor families still experience far more barriers to care than other children. A 2001 data, compared children of non-working poor parents and moderate to affluent children, found that more working poor children were uninsured (22% vs. 12% and 5% respectively;
P<.01) and experienced interruption in insurance coverage (P<.01). These figures persist after adjusting for other covariates.  

The current structure of dental care services provision complicates efforts to expand access. Unlike medical care, most dental services are provided in small practices with only 1 or 2 dentists, with relatively limited capacity to compensate for low Medicaid fees or offset costs of missed appointments.  

Although dental societies and some private dental practitioners participate in initiatives to reach underserved children, the number and distribution of such services are inadequate to meet the needs of these children.

**Financing dental care**

In data from 1996, sources of funding for dental care among children were as follow: out of Pocket (38.0%); private Insurance (37.4%); public Funding (4.4%); and not reimbursed (18.7%). According to estimates from Center of Medicaid Services (CMS), public funding for dental services in the U.S., measured in terms of current dollars (nominal), increased from $2 billion in 1996 to $5 billion in 2004, or from 4.5% of total dental expenditures to 6.0%. A considerable amount of public funding of dental care goes to hospitalization of young children who need extensive dental treatment and have behavior management challenges. In a study that examined the cost to the Iowa Medicaid program of hospitalizing young children for restorative dental care under general anesthesia, the authors found that the total cost to the Medicaid program of treating a child in the hospital under general anesthesia was $2,009 per case. Less than 2% of Medicaid-enrolled children younger than 6 years of age who received any dental service accounted for 25% of all dollars spent on dental services for this age group, including hospital and anesthesia care. The most frequent type of procedure was stainless steel crowns, with an average of almost six per case. However in another study that was conducted at the same setting, the authors evaluated the recall rate and caries experience of children treated under general anesthesia at The University of Iowa Hospitals and Clinics. After a retrospective chart
review, information from American Society of Anesthesiologists (ASA), patients undergoing general anesthesia between 1998 and 2002 were garnered regarding new caries experience; and treatment of new or recurrent lesions. Fifty-four percent of the patients returned for a 2 week postoperative visit, but only 13% returned for a 6-month recall, with subsequent recalls being even lower; 72% were insured by Medicaid; and 25% had recurrent or new lesions at follow-up appointments. This study showed that subjects who end up going to GA for dental care continue to struggle with this disease. This confirms that we, as dental professionals, approach the dental caries, especially among children, from a wrong perspective. Adoption of a new model that identifies early factors that can influence the disease, and the microorganisms balance and practice more cost effective operative modalities that can stabilize the disease during the process of lowering patients’ risks may results in a true cure of the disease not only its symptoms.

**Approaches to control dental caries among children**

As noted above, an overall decline in prevalence and severity of dental caries has occurred in child populations; however, an increasingly skewed distribution, with most disease found in a small number of children; and concentration of caries in pit and fissure lesions. Thus, preventive and restorative therapies should be combined to control the disease.

**Preventive therapies**

Exposure to fluoride is usually seen as the principal reason for the caries decline, especially smooth surface caries, with little change in oral levels of cariogenic organisms or the annual consumption of sugars.

While, water fluoridation is a cost-effective prevention that is aimed at the whole population, more expensive preventive activities should be target populations at risk or individuals at risk. Other principal population strategies are the regular use of fluoride toothpaste and public education that emphasizes oral hygiene.
Individualized preventive treatment in private clinics or schools and community settings that proved to be effective with high risk patients and had a long history of use to prevent dental caries such as professional topical fluoride therapies, home fluoride mouth rinses, and concentrated tray/brush-on therapies, antimicrobial agents, dental sealants, diet counseling, chewing xylitol-containing gums and oral hygiene.

Restorative therapies

Modern dentistry suggests that dental care for children should be grounded in preventive services and supplemented by restorative therapy; however, untreated cavitated lesions are still prevalent among children and restorative therapy is necessary to eliminate those cavities and facilitate plaque removal and control. Restorative therapy is also essential when there is need to restore tooth integrity to prevent space loss or diseases progression into dental pulp.

Appropriate dental care in a child requires an understanding of the carious process that includes the patient’s age, caries risk, prior therapy outcomes, location, and extent of the lesions. Therefore, a child who is caries active may require frequent diagnostic procedures, preventive therapies and more innovative restorative therapies.

Caries stabilization techniques

Classical strategies

Historically, there were a variety of restorative treatment options to choose from in managing the mild to moderate carious lesion. A while ago, it would have been fair to describe the predominant treatment philosophy as being reactive and focusing on operative treatment intervention. When lesions were detected, and often when they were suspected, they were restored, and the earlier the better.

The traditional G.V. Black approach requires the removal of the caries as well as enough sound tooth structure in order to achieve resistance, retention and convenience forms in preparation design, thus allowing an adequate bulk of the amalgam to gain adequate
strength. On the other hand, there were newer “tooth colored” generations of materials, which provide an advantage over amalgam in that they can form a chemical bond to properly prepared tooth structure, this allows for practitioners to limit the removal of tooth structure to decay. These materials included composite resin materials, and different types of glass-ionomer.35

Alternative strategies

Over the past several decades, advances in materials and technology and changes in caries epidemiology have all contributed to the rise of a more proactive, tailored preventive and restorative treatment philosophy characterized by greater attention to the individual patients and their diseases, with less emphasis on universal immediate surgical intervention.

The current understanding of dental caries as an infectious, communicable disease36 and an ongoing dynamic process of demineralization and re-mineralization37 that is modified by patient behavior, introduced two important interrelated concepts in caries control, risk assessment and minimal invasive intervention. Risk assessment is a crucial component in the decision-making process for the correct prevention and management of dental caries and is one of the pillars of the Minimal Invasive Dentistry (MID) philosophy.

Minimal Invasive Dentistry (MID)

MID is “a systemic respect for the original tissue”.38 The concepts translates the correct diagnosis of risk and lesion assessment; institution of targeted preventive treatment to stop disease; restoration of lesions with as little removal of health tissue as possible; use of durable materials and prevention of disease recurring.38

The focus on restorative treatment should be directed to increase the rate of restoration survival. This could be achieved more successfully by addressing the conditions that caused caries in the first place and second to make fillings less prone to fracture. Removing a minimal amount of healthy tooth structure and make smaller adhesive fillings will achieve big part of this goal.38
There are various promising techniques available for removable or disinfection of infected or affected carious dentin layers that will allow more patient-oriented less invasive treatment of existing defects. Under these circumstances, enamel preparation is only necessary to ensure proper access for dentine treatment and penetration of acids, adhesives and flowable restorative materials. Several techniques have been proposed such as: ART, oscillating systems, air abrasion and hydrokinetic system (lasers). Other specific cavity preparation techniques that were encouraged by minimal invasive dentistry were “slot” or “box” preparation, the proximal “tunnel” restoration and the preventive resin restoration. And finally the Hall technique which aims to restore asymptomatic primary carious molars with stainless steel crowns without significant preparation.

The concept of ART

ART was pioneered in Tanzania in the mid-1980s as part of a community-based primary oral health program by the University of Dar el Salaam and the support of the World Health organization (WHO). ART was needed to make oral care more available for the majority of people in economically less developed countries.

ART consists of “caries removal using hand instrument only, combined with the use of a modern restorative material with adhesive characteristics”. Currently, GI that leach fluoride and minimize the onset of secondary caries are used.

ART advantages and limitations, as cited by the original article that described ART for the first time in the literature were the subject of research over the last 16 years. The use of available and relatively inexpensive hand instruments; a biologically tooth friendly approach; limitation of pain; need for simple infection control; chemical adhesion of GI, the leaching of fluoride from GI; the combination of preventive and restorative treatment (ART sealants); the ease of repairing the defects; and the low cost were among the advantages of the use of ART.
On the other hand, many limitation were cited in the same reference: the need for more research to confirm the long-term survival rates; the acceptance of the procedure by oral health personnel is not yet assured; its limited use to small to medium sized cavities; the possibility of hand fatigue during instrumentation; the apparent lack of sophistication of the technique, which might make it difficult for ART to be easily accepted by the dental professional; and misconception by the public that the GI ”white fillings” are only temporary dressings.45

Although ART was developed to solve a problem in less economically developed countries, its philosophy and technique were the result of oral health research done in the economically developed world.45 This research included the study of: 1) the longevity of amalgam restorations in general practice. Although it was thought to be a permanent restoration, research results showed that amalgam lasted 6 to 10 year on average;49,50 2) adhesive restorative materials (composite and GI) which opened up the possibility of minimal invasive intervention;51,52 3) the fate of caries-inducing microorganisms under fillings and sealants that showed reduced viability and numbers over time53,54; and 4) the need for complete caries removal, where some evidence suggested that perhaps caries need not always be removed completely when the cavity is very deep.55,56

Because ART was developed originally as a solution for access to dental care in developing countries, the majority of the studies that investigated the survival rates of ART restorations were conducted under field studies in those countries. Those studies will be reviewed in the following section.

**ART in field studies**

Most of the studies followed ART restorations for periods of 6, 12, 24 and 36 months.57, 58, 59, 60, 61, 62, 63, 64, 65

However three studies in Tanzania,66,67 China,68 and Syria69 extended for more than 6 years. Earlier studies evaluated single surface ART restorations (class I and class V)70, 57, 71, 60, 61, 62, 63, 64 after that, studies that evaluated multiple surfaces were
initiated. The main dental material used in these studies was GI with different viscosities and manufacturers as the original World Health Organization ART manual recommended; however few studies tried to evaluate other materials in clinical settings. 72,73,74,75

What is interesting about these field studies is that they evaluated ART in different settings: schools, clinics, and in field hospitals and in different countries with different cultures and oral health care systems. 76 Some of these studies evaluated the application of ART glass ionomer fissure sealants in which requires only wiping the excess of the restoration over the adjacent fissure and applying finger pressure. 70, 77, 78 ART sealants were evaluated for its survival rates in some studies and for its caries preventive effect success rates in some others. 79 In addition, different assessment criteria were used to evaluate ART restorations and ART sealants in different studies. Most of those studies had used the ART criteria for evaluating survival of sealants and restorations. 80 Usually, the United States Public Health services (USPHS) criteria are used to assess restorations’ survival; one study applied both the ART and USPHS criteria to the same ART restorations in permanent teeth and reported no significant differences in survival outcomes of ART restorations between the two sets of criteria. 78 Initial ART studies used medium-viscosity GI (1.5:1< powder: liquid ≤3.6:1) 81,82,83,66,67,77,84 but these were succeeded by high-viscosity GI (powder: liquid ≥3.6:1) in the mid-1990s. 85,68,63,64,69,87,88,89,90,65

To sum up the results of field studies over the last two decades, a recent meta-analysis in 2010 showed that survival of ART restorations was 93% over 2 years in single surface restorations and 62% in multiple surface restorations in primary teeth. 91 In permanent teeth, survival was 80% over 5 years in single surface restorations and 86% over one year in multiple surface restorations. Another meta-analysis in 2011 showed that when compared with amalgam, there was no significant difference between the two restorations after 12 and 24 months in primary teeth. 92 In permanent teeth ART
restorations survived better than amalgam for up to 6.3 years but survival was site-dependent; occlusal restorations had higher survival rate than occluso-proximal restorations.  

The previous results indicates that the survival rate of single-surface ART restorations is acceptable, and qualified to meet the American Dental Association (ADA) specification for quality restorations, especially for single surface restorations.

Given that those results were for restorations that have generally been placed under field conditions, survival rate of single-surface ART restorations could be even higher if the procedure is performed in the dental clinic under more ideal conditions as will be discussed in the next section.

**ART in standard dental clinics**

ART was originally developed for and introduced to populations who lived in economically less developed countries. However, it also has applications in economically more developed countries, especially for: very young children who are being introduced to oral care; patients who experience extreme fear or anxiety about dental procedures; mentally and/or physically handicapped patients; home-bound elderly and residents of nursing homes; and patients with high-risk caries who can benefit from ART as an intermediate treatment to stabilize conditions. In most of the ART studies, the ART approach was used in the permanent dentition among populations with low caries risk in developing countries.  

The survival rates were very high for one-surface restorations and moderate for class II restorations. Before maximal benefit of the treatment can be established, it has been suggested that the appropriateness of ART should also be tested in children with high caries risk and among patients with rampant caries in modern clinic settings. Also it will be of importance, after obtaining satisfactory results from field studies, to test the use of ART in modern clinical settings. However, few studies with small sample sizes have been reported the use of ART in such settings.
The most relevant study, to assess the feasibility of the ART approach in primary teeth and to compare the ART approach with traditional amalgam restorations in primary molars in a modern clinical setting, was conducted in a study population, 47% of it is affected by caries in their anterior primary teeth. This study was conducted in a pediatric dentistry clinic in Kuwait in 2001. The ART and amalgam class I and II restorations were placed randomly on comparable pairs of primary molars, if available. In addition, the ART approach was used for other primary teeth that had no pulpal involvement and no perceived pain before treatment. For ART restorations, a hand-mixed, high-strength, chemically activated glass-ionomer was used and for control cases, an amalgam Megalloy was used. Most of the patients were referred to this clinic because of their un-cooperative behavior and all had high caries risk. The restorations were assessed by both the ART evaluation criteria and USPHS criteria in 2000 and in 2001. The mean follow-up period for the restorations was 8 months in the first assessment (2000) and 22 months in the second assessment (2001). The assessment was possible for 35 children with mean age of 5-7 years, 18 of whom had comparable pairs of restorations in their primary molars. In addition, 48 other ART restorations were assessed in 2000 and 42 in 2001.

In a 2-year follow-up, 90% of all ART restorations were considered successful. The failure rate of the comparable pairs of ART and amalgam restorations was 6%. There was no significant difference in success rate between ART and amalgam techniques. The authors concluded that class I ART restorations seemed to have a high success rate, indicating the appropriateness of the ART approach in primary teeth.

In this study, the authors indicated that an important advantage of the ART approach was the low level of pain and discomfort experienced by the children, who were young and often very anxious. In many cases, the ART approach as the first treatment option was much easier than traditional caries removal. Some of the parents were very surprised to hear that “the restorations could be placed on teeth without any drilling at all”.
Besides, the high survival rate of ART, this study demonstrated a very important application of ART; it is useful in very young and uncooperative children where behavior management of the children is a challenge.

**ART as a less traumatic restorative treatment alternative**

It has been stated that 10%–20% of the adult population in the Western industrialized world report high dental anxiety that developed during childhood. And it is well known by now that a main barrier to early intervention of children is dental fear. “Dental fear is related to direct conditioning and parent modeling factors and significantly reduces the proportion of mothers who take their children to the dentist”. Often, children and their mothers are caught in a cycle of untreated disease leading to painful and more complicated dental treatment and mothers report that they don't take their children to the dentist until something hurts. Survey work at the University of Washington suggests that fear of dental treatment is a major problem, with 66% of fear acquired in early childhood as a result of this symptomatic approach to dental care.

ART could be a good solution to introduce restorative care to very young and uncooperative children. ART was investigated in many studies in modern clinical setting as an alternative treatment option to restore carious teeth in young and uncooperative children in which fear and anxiety were the reasons behind the unmanageable behaviors of children in dental chair.

To assess the atraumatic nature of ART, some studies have explored the pain, anxiety and discomfort that could accompany the ART procedure and compared it to conventional treatment methods. In a study by Schriks et al, the authors found that children treated according to the ART approach using hand instruments alone experienced less discomfort than those treated using rotary instruments. The aim of the study was to explore a possible difference between the extent of discomfort experienced during dental treatment of multi-surface cavities in deciduous molars according to the ART approach and a method using conventional rotary instruments. For the purpose of this study, the authors
considered both the physiological (heart rate measurement) and the psychological aspect (Venham scale) to be representative indicators of discomfort. However, the influence of the culture and values of this specific community could affect the generalization of the results. A study in Suriname, and using the same methodology, found the same results that children receiving dental treatment using hand instruments only and without local anesthesia experienced less discomfort than children who were treated with burs and local anesthesia.

Moreover, a third study that used different measurement of dental anxiety, the Short Form of the Dental Subscale of the Children’s Fear Survey Schedule (CFSS-SF), in Johannesburg, South Africa found that dental anxiety was lower when ART procedures was used to restore carious teeth in both adults and children.

Some researchers have preferred more objective measurement, such as blood pressure and pulse rate to measure dental anxiety. These two measures were used in a study by Wang et al which used physiological measures only. In this study, the authors, who evaluated the effect of three caries removal methods on children’s dental fear, found that using chemical agents and ART to remove caries and restore cavities resulted in lower levels of dental fear.

Different studies among different countries across the world evaluated the dental anxiety accompanied with ART, using more subjective reporting systems, in which patients themselves report the pain they felt during treatment, agreed on the atraumatic nature of this procedure. For example, in Pakistan, 19% of the ART treated patients felt pain during treatment compared to 36% among conventionally treated patients; in Mexico, among 370 ART restorations in 118 five to eighteen year old children; 85% reported no pain, and 93% were comfortable with their restorations. In an older age group, 14 and 15 year old children in Egypt, pain was experienced in ART only when large and deep cavities were treated. In 5 regions of the Western Cape Province of South Africa, where caries prevalence exceeds 60% and remains mostly untreated, a pain assessment among six
hundred 6 to 9 year-old schoolchildren treated with ART indicated that 80% of subjects experienced no pain, 18% reported discomfort and slight pain, and 2% required local anesthetic. And finally among Chinese preschool children, 93% of the children reported that they did not feel pain during ART treatment and 86% were willing to receive ART restorations again.

Similar studies in more industrialized countries and for younger children are lacking, but in a study by Rasmussen et al. of attitudes of Danish dentists towards the management of procedural dental pain in children, 74% of the dentists thought that a 3-5 year old child could report pain with some certainty. In addition, administering a mandibular block to preschool children was perceived as the most stressful pain control option. In addition, 58% of the dentists were willing to restore superficial cavity without analgesia, while only 8% of the dentists were willing to restore deep cavities without analgesia. These attitudes were reported regardless of the cavity preparation method used. In another study carried out in Sweden by Ingegerd et al., the authors investigated the characteristics of 186 pre-school children referred to a pediatric dentist because of uncooperativeness in the dental clinic. Thirty seven percent of those children had at least one hospitalization experience and 38% of those exposed to drilling refused this procedure a second time.

In summary, most would agree that treating very young children for the first time shapes their commitment to dental care in the future. The child who feels less discomfort and pain in dental treatments will be more willing to be engaged in routine dental care visits and this positive attitude will be passed on to his or her family in the future. And most would agree also that a young, apprehensive, pre-cooperative child with multiple carious lesions in need of dental caries is quite a challenge.

In the US, the percentage of unmet needs in oral care among children is still relatively high and several factors may contribute to these unmet needs. However, it is believed that the traditional way of treating cavitated dental lesions, which is largely based on the use of rotary equipment that requires frequent administration of local analgesia, is
responsible in provoking fear and triggering dental anxiety among children. The ART approach has been well received by both children and adults and most of the previous studies have suggested that ART, which is based on hand excavation and the infrequent use of local analgesia, causes less pain and anxiety compared to traditional methods.

Equally important to the atraumatic nature of ART, is the cost effectiveness of ART which make it a good option for children who cannot afford the more expensive traditional treatments or at community and public health setting where managing the costs of treating children at reduced fees is a challenge.

**Cost effectiveness of ART**

A study was conducted to establish and compare the estimated cost of an amalgam, composite resin and ART restoration in South Africa. The study used recommended scale of benefits at the School of Oral Health Sciences and Oral and Dental Hospital, University of the Witwatersrand (SOHS). Fixed and variable costs were calculated by pricing items and equipment used in each procedure. The output values were established according to the recommended scale of benefits (BHF, 1999). This enabled the calculation of contribution margins and net income for each of the three restorations. Some definitions used in this study were capital cost, which is all equipment and instrumentation, likened to depreciation, used in each procedure; variable costs, consumables used in each procedure; fixed costs, computed as capital cost as well as the salary equivalent for time spent on the procedure; and output value, the benefit values set by the university scale fees was used to represent as the total income. The annual capital cost for the ART approach is approximately 50% of the other two options, despite the fact that ART restorations are provided in a modern dental setting.

The study concluded that implementation of the ART approach within the clinic setting of the SOHS can be achieved without additional cost. Furthermore ART can be performed as an economically feasible alternative to conventional treatment procedures
within the clinic setting. The authors added that this study represented a first step towards determining the cost efficiency of implementing ART as a practical and cost-effective restorative option within the SOHS, University of the Witwatersrand.\textsuperscript{113}

This study had its limitations. First, the researchers used a simplistic manner of costing; however any inclusion of other service and maintenance items wouldn’t influence the final cost because they are standard for the three procedures. Second, the assumption that the output value of an ART restoration equals amalgam can be debated.\textsuperscript{113} Third, the economic analysis that was carried out in this study is unique to this teaching setting and to the region in the world; however, the 50% savings achieved on materials and capital outlay would remain constant in other clinical settings as well.\textsuperscript{113}

In the US, certain underserved population will certainly benefit from the low cost of ART restoration to achieve equity in access to dental care. However, the use of ART in the US is not well studied.

\textbf{The use of ART in the US}

Globally, the World Health Organization (WHO) recognizes ART as part of package of oral care for the community. They view ART as an innovative highly effective approach suitable for populations at all levels of economic development and they believe that ART fits modern concepts of preventive and restorative oral care, with stress on prevention and minimally invasive restorative care.\textsuperscript{114}

In addition, the International Dental Federation (FDI) believes that ART has a place in modern dentistry: “The ART approach is consistent with modern concepts of preventive and minimally invasive restorative oral care. Importantly, pain and discomfort are rare during treatment, virtually eliminating the need for an anesthetic. Since few dental instruments are used, cross infection control is easy to achieve”.\textsuperscript{115}

The American Academy of Pediatric Dentistry recognizes two different therapeutic types of ART. “Application of GI, where fluoride release has advantages, can be for Interim Therapeutic Restorations (ITR) and the Alternative (atraumatic) Restorative Technique
(ART)”. These procedures have similar techniques but different therapeutic goals. “ITR may be used in very young patients, uncooperative patients, or patients with special health care needs for whom traditional cavity preparation and/or placement of traditional dental restorations are not feasible or need to be postponed. Additionally, ITR may be used for caries control in children with multiple open carious lesions, prior to definitive restoration of the teeth”. “ART, endorsed by the World Health Organization and the International Association for Dental Research, is a means of restoring and preventing caries in populations that have little access to traditional dental care and necessarily functions as definitive treatment”.

In a study by Seale et al that was conducted in 1997 to gain information from members of the American Association of Pediatric Dentistry (AAPD), about how they treat children 3 years old or younger and the problems they encounter. The authors found that pediatric dentists used a variety of techniques in offering care for young children and they were interested in receiving more information and help from the AAPD for guidelines about the best treatment options in young children. In a sample that was claimed to be representative of the 6 US regions (43% response rate), 71% of the pediatric dentists used GI as their material of choice and 51% used ART in preparing cavities. However; 89% used more aggressive definitive techniques such as stainless steel crowns (SSC) in providing care for young children.

For enamel lesions, 87% used preventive maintenance, and for enamel and dentinal lesions, 40% used GI. Interestingly, pediatric dentists found that GI treatment (more conservative approach for cavity restoration) was more effective among Medicaid patients than privately insured patients. This could be because Medicaid patients typically have more levels of the disease and need more caries stabilization procedures such as ART and caries preventive materials such as GI, or it could reflect differences in Medicaid reimbursement between materials.
In another study by Seale and Casamassimo which was carried out in response to concern that inadequate dental school training may create a barrier to access to care for children, the authors conducted a survey concerning general practitioners’ practice patterns involving child patients. The authors sent a written survey to an ADA random sample of 4,970 general practitioners asking whether and in what numbers they treat children; the ages and caries levels of any children they do treat; their perceptions of their educational experiences in pediatric dentistry, and their perceived needs for continuing education in pediatric dentistry. Ninety-one percent of the general dentists surveyed treated children, but very few treated those younger than 4 years of age, those with high levels of caries, and those whose care was funded by Medicaid. The types of patients treated and procedures performed by the respondents were significantly associated with the intensity of the respondents’ educational experiences, except for the number and types of Medicaid patients they treated. Fifty-five percent placed amalgam in primary teeth (very often/often), 51% placed resin-based composite restoration in primary teeth (very often/often), 44% placed preventive resin restorations in primary teeth and 17% of general practitioners placed stainless steel crowns (very often/often). ART was used (very often/often) by 44% of general practitioners; however, 28% of GPs (rarely/never) used ART in their practices. These low percentages of restorative modalities provided could be due to the low caries levels found in patients of this sample of GPs, in which they reported an average of 67% of their patients had no or mild caries experience. It is interesting to note that restorative options varied with the caries experience of targeted patients. This was true in a previous study (116) by one of the same authors when the use of GI was more common among Medicaid patients who were expected to have higher caries levels.117

In a third study by the same author (Seale), among 126 pediatric dentists in Florida, 85% of the respondents used Stainless steel crowns, 63% used amalgam, 56% used hybrid composite and 37% used resin modified GIs when they were asked about the material of choice and cavity preparation type used in primary teeth. Eighty five percent of respondents
applied G.V black type of cavity preparations. As stated earlier, pediatric dentists seem to be more willing to use definitive treatment options with children than GPs. This could be due to the type of training or the more complex needs of their patients.\textsuperscript{108}

The under use of ART may be a reflection of a negative attitude towards ART; Dr. Sarll, past president of the British Dental Association explained the under use of ART in developed countries as ART might well be viewed as “a way of legitimizing inferior care using rudimentary instruments and crude techniques”.\textsuperscript{118} Another explanation of the underuse of MID procedures in general, including ART was posed by Ericson et al when he stated that “we have the means, motives and opportunities for MID, but there may be lack of economical incentives” then he adds “here we touch upon Achilles heel of the practicalities of MID, as many reimbursement systems do not recognize MID procedures, the pecuniary incentives are often lacking, an important fact that must be addressed if our profession is going to change”.\textsuperscript{119}

This attitude may be one of the barriers that prevent convincing the majority of dental professional to adopt new less invasive simple restorative techniques such as ART.

\textbf{Barriers to adopt new restorative techniques in dental practice and dental training programs}

There are few studies that discussed barriers to adopt new restorative or preventive modalities among dentists or dental training programs. The initial introductions of fissure sealants, posterior composites, tobacco cessation programs, and other preventive modalities, are examples of how new procedures, practices, techniques, and devices are adopted or resisted by practitioners. It is not a straightforward process; complex personal, environmental and organizational factors could influence the willingness of dentists or program directors to incorporate a well-documented restorative or preventive technique in their practices or their curriculum. Some researchers have suggested using the diffusion of
Innovations, Roger’s behavioral theory, as a model to explain the attitude and behavior of professionals towards new techniques such as ART.

In a study assessing the readiness of dentists’ offices to adopt tobacco cessation activities, the author found dentists could be classified among the five categories of Roger’s theory: Innovators, who are willing to adopt new ideas early and easily; Early adopters, who are eager to try new things but more cautious in their decisions; Early majorities, who follow the lead of early adopters; late majorities, who are skeptical of new ideas; and finally the laggards, who are suspicious of both innovations and the change itself.  

Other studies, in spite of not using certain theoretical frameworks, have discussed factors and concerns of dentists that may influence the adoption of new techniques in dental practice or dental training programs. 

In a study by Chapko in 1987, the author cited the reasons that dentists give for not using sealants. Those reasons, more than twenty years back are very similar to the reasons now used to undermine new techniques such as ART: concerns about failure, lack of confidence, preference of and concerns about leakage. However, clinical research has addressed those factors in different studies regarding fissure sealants or the use of ART. Lack of insurances coverage was hypothesized to be a major barrier to the use of sealant in this study. 

In the same line, and emphasizing the role of insurance coverage, a review of the literature that was conducted in the 1992 in the US, indicated that age, skills, training, preference, style, patients factors and insurance coverage were factors that explain some of the aspects of the dentists’ restorative treatment decisions. 

From another perspective, environmental and social factors also play a role in this process. In a study among English general practitioners that discussed the facilitating factors and barriers influencing change in dental practice, the authors found that network and environment characteristics were sometimes as important as personal characteristic in inducing change and adoption of new techniques in clinical practice.
factors, postgraduate qualifications and age were characteristics that could influence change. In addition, cost-benefit analysis was the main rationalizing process to decide on change.\textsuperscript{123}

Network and environmental factors were important also in a study carried out in 1997 to assess the adoptability of the medical model in caries control. In this study, the authors surveyed general dentists about their use of different caries-control services. Responses indicated that leaders in the dental community and those with a wider network of professional colleagues, who were early adopters, were likely to adopt new techniques more quickly than other dentists. Earlier adopters also had more correct information about these techniques than later or non-adopters. Some of the barriers that hinder the use of the new techniques were: lack of awareness, lack of interest, unawareness of the cost-benefit relationship, the desire of the patients, lack of insurance coverage, or lack of motivation to use these new techniques.\textsuperscript{124}

In a study from Australia, the authors found that gender, age, type of practice and location of the practice, (urban, capital, rural) can be predictors for restorative treatment decisions. Ability of the dentist, philosophy of the dentist, the need for specialist, practice profit/time-money ratio, and convenience to the dentist were also among the factors that affect the dentists’ decisions. However the author discussed that dentists usually use routines in their day to day practice, and this routine is based on clinical experience that develop those treatment decisions. Dental students have been shown to rank a larger number of factors as important when choosing treatment compared with dentists, because they have not yet developed routines for decision making. Thus, dental students are more receptive to new innovations, and teaching them a wide variety of techniques will give them a whole spectrum to choose from when they start their practice and start developing their own routines.\textsuperscript{125}

Factors that may influence the adoption of ART among other restorative and preventive procedures were discussed in a study from Brazil. In this study the authors found that male dentists tend more to use ART in their treatment than female dentists.
Among other factors such as type of university of graduation, post-graduation training, years from graduation, and source of scientific readings, gender was the only significant factor that indicate the more use of ART. 126,127

In a summary, complex interaction of personal, environmental, organizational and patients factors were facilitators or barriers for dentists to adopt new techniques or determinants in their treatment decision making. However insurances coverage was a critical factor among US dentists only, not British, Brazilian or Australian dentists. In a conclusion, developing evidence-based clinical guidelines adopted by professional and global organizations could facilitate the uptake of new innovations and the spread of cost effective, evidence documented restorative techniques. Continuing and formal education can provide the knowledge and the skills to master those new techniques and market for their use.

**The role of dental education in the formation of attitudes and behavior of dentists towards different caries managing techniques**

Dental education and academic dental institutions play an important role the nation’s oral health. Education, research, and patient care are the cornerstones of academic dentistry and the pillars of preparing future dentists who will provide care to the public.

Dental education should prepare competent graduates with skills and knowledge to meet the needs of all Americans within an integrated health care system; and to assist in prevention, public health, and public education efforts to reduce health disparities in vulnerable populations. The question remains as to what extent dental education impacts the attitude and the behavior of future dentists.

In a study evaluated dental students’ opinions and knowledge regarding caries management and prevention at the University of Florida College of Dentistry, a 26 item written survey instrument was administered to third- and fourth-year dental students; the response rate was 92.3 %. In their responses, the dental school was ranked first as the most
important source of professional knowledge and advice indicates that students rely and depend on the information they are provided in dental school. This is an expected response from students currently enrolled in the dental school. Lower rankings for professional meetings and conferences could be due to the students’ lack of exposure to professional meetings and, therefore, uncertainty about their potential informational value.  

An important question presented by Seal and Kendrick in their survey of post-doctoral pediatric dentistry program directors was whether program directors are preparing post-doctoral students to see all types of patients and provide all types of care. “Different patient populations may require different communication skills, may expect different restorative options and may demonstrate different levels of compliance”.  

School training was not the source of treatment decisions as viewed among dental students only, but also pediatric dentists ranked “Postdoctoral training” as second after “Personal philosophy” when they answered a question concerning the most important factors influencing treatment decision. This was a part of a survey of pediatric dentists’ management of dental caries in young children. This study was explained in more details later in the present study.  

In attempt to answer the previous question, a study by Seale and Casamassimo sought to gather information about faculty, patient pool, and procedures taught in pre-doctoral pediatric dentistry programs using a questionnaire sent to all fifty-five U.S. dental schools in 2001. Forty-eight (87 %) programs responded and reported an average of 3.9 full-time and 2.1 part-time faculty members, resulting in a mean faculty to student ratio of 1:6. One-third of the programs employed general dentists to teach pediatric dentistry and 36 % reported fewer faculty members than five years previously. Two-thirds were stand-alone departments not combined with other disciplines. Over half (55 %) reported increases in patient pools, but also a lack of patients with restorative needs. Half of the programs supplemented school-based pools with special populations, and two-thirds sent students on external rotations, most often to treat high-caries children. Those not using external rotations
cited lack of faculty. Patient age averaged about four years, with only 6% of the pool less than three years old. Low-income or Medicaid-covered children accounted for 88% of school patient pools. Half of the schools felt the pool inadequate to meet competencies, attributable to lack of patients' restorative needs or inadequate numbers of patients. Fewer than half of the programs (48%) provided hands-on experience with special health care needs patients, and one-third had the capacity to provide every student with this experience.\textsuperscript{130}

Results of this study suggest that U.S. pediatric dentistry pre-doctoral programs have faculty and patient pool limitations that affect competency achievement and unfavorably affect training and practice. In this survey, 96% of respondents had didactic knowledge about treating children 0-2, infant oral health and ART, while 14% reported actual patient experience with these types of procedures.\textsuperscript{130}

A study by Rich et al. investigated whether undergraduate dental education affects general dentists’ practice characteristics, attitudes, and professional behavior concerning the treatment of pediatric patients. In this study, the exposure was pre-doctoral training and the outcomes were the attitude, behavior, and practice. The sampling frame was the Michigan Association of Dentists, and a self-administered survey was distributed to all members.\textsuperscript{131}

The sampling method used in this study limits it generalizability to other dentists residing in states other than Michigan. Moreover, with a response rate of 45% and with no evidence to refute response bias presented in the study, one might suspect that the non-responding dentists could potentially have been more negative in their attitudes towards the treatment of pediatric patients than the responding dentists.\textsuperscript{131}

The survey consisted of 21 questions; the first group of questions was concerned with the respondents’ background, and the second section of the survey focused on the dentists’ perceptions of their educational experiences concerning the treatment of pediatric patients and their attitudes towards treating children patients. The answers were given on a 5-point answer scale ranging from 1=not at all to 5=very well. In addition, Dentists were
asked to indicate their disagreement/agreement with the statements “Dental school prepared me well to treat children” and “My clinical experiences in dental school prepared me well to treat child patients”. Questions in the third part of the survey were concerned with the dentists’ willingness to treat child patients in general.  

Respondents with more positive educational experiences agreed more strongly with the statement that their practice was set up in a way that facilitated the treatment of children compared to respondents who had less positive educational experiences. Dentists with more positive educational experiences in pediatric dentistry were more likely to report that their staff was comfortable and knowledgeable about treating children. Financial compensation for treating children was judged as more inadequate by dentists who felt less well prepared by their dental school programs than by those respondents who felt better prepared.  

In contrast to respondents who did not report that they were well trained in pediatric dentistry, dentists who perceived that they had been well prepared to treat children between three and six years of age and between six and nine years of age reported that they provided more different types of treatment for pediatric patients, were less likely to refer these patients, and were more likely to offer special arrangements, and more special accommodations for pediatric patients.  

The methods used here don’t answer the research question adequately; first because it is not an objective analysis of dental curriculum and comparison with future behavior, attitude and practice. It is more a perception of those dentists to the dental education and clinical training they had, so it is merely a subjective analysis of those curricula. Second, the effect of recall bias among some of the respondents was not addressed in this study. One of the respondents was 84 years old; this means that he answered this questionnaire 60 years after his graduation.  

The results of this study underlined the importance of dental education for future providers’ practice characteristics, attitudes, and professional behavior concerning the treatment of pediatric dental patients. These findings together with the findings by Dao et al.
in 2005 concerning the treatment of special health care needs patients and by Smith et al. in 2006 concerning the treatment of underrepresented minority patients support the argument that the scope and quality of dental school educational experiences influence future providers’ attitudes and professional behaviors concerning the treatment of their patients.

The author sees “these deficits in educational experiences as troubling because dentists’ perceptions of the quality of their educational experiences were clearly related to their willingness to provide a variety of different treatments for children as well as their attitudes about pediatric care” and here he related the “dentists’ perception” of their education with their future attitude. These findings strongly suggest that educational experiences concerning the treatment of pediatric dental patients will shape future dental care providers’ attitudes and professional behavior. “Given the inadequate access to dental care for children, it seems crucial to carefully evaluate undergraduate dental curricula to ensure that future dental care providers receive sufficient educational and especially clinical experiences concerning the treatment of child patients”.

The role of education in future practitioners’ attitudes was explored further in a study by Cotton et al. In this study the authors investigated the willingness of general practitioners to provide dental care for preschool-aged children, and investigated the relationship between dental school experiences and practitioners’ attitudes about treating Medicaid-enrolled children 3 years of age and younger. A survey was mailed to 3,559 randomly selected general dentists in Texas. Respondents were asked to answer questions about their willingness to provide specified dental procedures for children of different ages, their dental school experiences with pediatric dentistry and whether these experiences were hands-on, lecture or no training. In addition attitudes towards treating Medicaid-enrolled children, 3 years of age or younger were addressed in this survey. Associations between attitudes about treating Medicaid-enrolled children and dental school experiences were determined. With a response rate of 26%, almost all respondents were willing to provide routine procedures such as an examination (95%) and prophylaxis (94%) for children 5
years or younger; However, for younger children and more difficult procedures, the number of general dentists willing to provide treatment decreased. The level of dental school training was significantly associated with the favorable attitudes of general dentists towards providing dental care for Medicaid-enrolled preschool-aged children. This was clear when dentists who had dental school experiences with children less than 3 year old were significantly more likely to be comfortable with treating these children. However, the low response rate and possibility of recall bias about dental school curriculum could make generalizability of these results limited.\textsuperscript{132}

Another study that explored cross-sectional data, and agreed with previous studies about the role of education in dentists’ future decisions and practices, was a study by Smith et al. This study explored dental students and dentists’ perceptions of their education and studied the relationship between dental education and their attitudes and behavior. Data were collected from 328 dental students (response rate, 77.5\%) and 234 alumni (response rate, 43.7\%) of University of Michigan Dental School. Only 67.4\% of the students and 38\% of the alumni indicated that their education had prepared them well to treat patients from different socioeconomic backgrounds; 71.3\% of students and 55.2\% of alumni responded that they had been well educated to treat patients from different ethnic or racial groups. The findings showed a positive relationship between the degree of curriculum focus on the importance of treating patients from all aspects of society and students' and alumni intentions to provide care to patients from diverse backgrounds. The more students agreed that their dental education had prepared them well to treat patients from different ethnic backgrounds; the more likely they were to report that they intended to treat these patients. Similarly, the more the alumni agreed that their dental education had prepared them well to treat patients in different communities, the more likely they were to treat patients from different socioeconomic backgrounds. These findings showed that dentists’ attitudes are largely based on their dental education; however this survey was carried out in one dental school and the respondents sample may not represent all US dentists.\textsuperscript{133}
Another important study by Casamassimo and Seale analyzed a data subset from a national survey of general dentists conducted in 2001 to determine their overall care of children with special health care needs (CSHCN), indicated contradictory results. In the survey, dentists were asked to respond to questions from the following areas: did they provide care for CSHCN; what were their perceptions of the training they received in dental school related to CSHCN; what was their interest in additional training for CSHCN; and what factors influenced their willingness to provide care for CSHCN. The results of this study showed that about 10% reported treating CSHCN “often” or “very often”, and only one in four respondents had hands-on experience with these patients in dental school. Postgraduate education in general practice or advanced general dentistry residency had no effect on willingness to care for CSHCN. Older dentists, those accepting Medicaid for all children, and those practicing in small communities were more likely to see CSHCN. Dentists willing to see CSHCN also were more likely to perform procedures associated with special health care needs and underserved child populations including pharmacologic management and stainless steel crowns. Dentists with hands-on educational experiences in dental schools with CSHCN were less likely to consider such factors as level of disability and patient behavior as barriers to care and were more likely to desire additional education in care of CSHCN. Results of this study on the effect of education offer some contradictory results of care of CSHCN. Supporting the positive effect of education on the likelihood of caring for CSHCN was the finding that dentists who had not been exposed to hands-on and lecture were less likely to care for these patients. It is also encouraging to note that dentists who had been educated in CSHCN care perceived fewer barriers to providing care to special needs patients. However, those with advanced education in General Practice Residency (GPR) and Advanced Education in General Dentistry (AEGD) programs were not more likely to care for CSHCN, while older dentists who tended not to have had special needs patient education were more likely to care for these patients. This may simply reaffirm the “complexity of a dentist’s
attitude and behavior towards certain procedures or certain populations is based on financial, attitudinal, and educational factors.”.  

Confirming that other possible factors may affect dentists’ practices, a study in Florida surveyed the behavior of pediatric dentists in restoring primary teeth. The study found a conflict between what is taught in pre and post-doctoral pediatric programs on material choice for primary teeth restoration and what was practiced among the respondents. In this study, resin-based materials were the most commonly selected for class I and II restoration. According to another study that surveyed the teaching of Class I and II cavities in the US dental schools, amalgam was the material of choice for such cavities. A possible explanation for the Florida study that the use of tooth colored resin materials among pediatric dentists in Florida could be mainly due to the patients’ demand for more esthetic restorations.

In summary, there is good evidence that pre and post-doctoral education have great impact on future dentists' attitude and behavior, at least in the first years of their practice, before developing personal routines that dominate the clinical judgment afterward. Thus a survey of dental educational institutes in the US to assess the learning experience that is provided on ART to future dentists is a must to fully assess for overall assessment of the extent and types of ART used in the US.

**Aims of this project**

This project was an exploratory study and aims to assess the factors related to:

1. The level of didactic instruction and clinical training on ART provided to pediatric dentistry residents in the US.
2. The level of didactic instruction and clinical training on ART provided to dental students in the US.
3. The attitude of post-doctoral pediatric dentistry residency program directors towards ART.
4. The attitude of pre-doctoral pediatric dentistry program directors towards ART.
5. The willingness of pediatric dentists in the US to use ART with their children patients.
CHAPTER 3: THE GENERAL METHODS

Introduction

This dissertation is comprised of three separate studies. The three studies investigated the use of Atraumatic Restorative Treatment (ART) in different settings. The main goal of this dissertation was to assess the extent of use of ART in pediatric dental education and pediatric dental practice.

In study I and II, we used the same survey instrument with little modifications to survey:

1. In study I, post-doctoral pediatric dentistry program directors.
2. In study II, pre-doctoral pediatric dentistry programs directors.

In the third study we used a different survey instrument and a different design to survey:

3. Pediatric dentists in the US (Study III)

General research perspective

Using an electronic survey, self-reported use of ART in educational training institutes (study I and II) and rating conjoint scenarios about ART among pediatric dentists (study III) were used to better understand the extent and the types of ART used in the US. A survey was an appropriate method to describe the characteristics of our population of interest and to explore factors related to the use of this technique among educators and professionals in pediatric dentistry field.

Our populations of interest in the three studies have an easy access to the internet and sampling frames of email addresses were available from professional organizations.

The survey instruments that were used in the three studies were tested for content and face validity by cognitive analysis interviews and pilot testing.
Participants

The participants in three studies were three distinct populations: post-doctoral pediatric residency program directors in study I, pre-doctoral pediatric dentistry program directors in study II and pediatric dentists working in private and other non-private settings in the US in study III.

The AAPD member list and the ADA’s accredited pediatric dentistry residency programs list were used to create a database of email addresses for study I; the AAPD member list and the ADA’s accredited dental school list were used to create a database of email addresses for study II and finally the AAPD member list for pediatric dentistry specialist was used to create a database of email for study III.

Representativeness of the sampling frame

The AAPD member list includes all post-doctoral pediatric dentistry program directors in the US, a list of all pediatric dentistry department chairs in all ADA accredited dental schools and all pediatric dentists who are registered by the AAPD as specialists in the US.

The ADA accredited advanced pediatric dentistry training programs list was used to verify the inclusion of all post-doctoral pediatric dentistry programs. In addition, the ADA list of accredited dental schools was used to ensure the inclusion of all pre-doctoral pediatric dentistry programs.

Collectively, the AAPD and the ADA organizations are ideal source from which to obtain samples of our three populations.

Materials for study I and II

The primary research instrument used in study I and II was a pretested web-based questionnaire with 51 items. The survey was pre-tested for content validity, using cognitive analysis (consulting and pre-testing 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 at the University of Iowa during spring of 2010. Pilot testing for face validity was carried out by two pediatric dentistry senior residents, and two dental public health senior residents.

**Description of the survey instrument for study I and II**

The questionnaire was divided into five sections: (I) program directors' characteristics, (II) program characteristics, (III) the characteristics of the patient population served by the program, (IV) the attitude of program directors towards ART and (V) the level and format of didactic and clinical instruction on ART. Besides the demographic characteristics of the program, section II included questions about the use of behavior management techniques in the program (2 questions), and the use of different Minimal Invasive Techniques (MID) in the program.

**Independent variables in study I and II**

The key independent variables included in the analyses were program director's age, gender, number of years since gradation, the type of program affiliation (hospital, dental school, or community-based), frequency of the use of different behavior management techniques used with children younger and older than 3 years old (non-pharmacological, protective stabilization, nitrous oxide, sedation, general anesthesia), frequency of the use of amalgam in the program (primary teeth and permanent teeth), the use of MID techniques in the program (composite variable) and program director’s attitude towards ART (composite variable).

**The composite variable, the use of MID techniques used in study I and II**

Two versions of this scale were used in study I and II. Study I included 11 MID procedures and study II included 14 procedures. Those procedures were agreed on during the cognitive analysis phase of questionnaire development. The scale was the sum of responses to the 11 questions each measured on a five-point frequency scale (never =1, rarely, sometimes=3, often=4, most often=5). The internal consistency of the scales was
measured by Cronbach’s alpha which was 0.7 in both studies, suggesting a high level of consistency. The scale was used as a predictor variable in our model. For this scale, a respondent who scored “never” all the time would have a total score of 11 in study one and 14 in study II. The respondent who scored “most often” all the time would have a total score of 55 in study I and 70 in study II. Table (4)

The composite variable regarding Program directors’ attitude towards ART that was used in studies I and II

This scale was used an intermediate variable in our model (acted both as a predictor and outcome variables). The agreement or disagreement of program directors with 10 statements about ART was measured on a five-point likert scale. The scale summed the scores for each sub-question, 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 0.8. Table 5

Dependent variables in study I and II

1. Didactic instruction: was measured by the question “Does your program’s didactic instructions teach that preparing cavities using only hand instruments can be a proper technique in certain situations?” and the response was dichotomized as Yes or No.

2. Level of clinical training provided on ART: was measured by the question “How often do the pediatric dentistry residents use ART as a caries management technique for their patients?” Response were measured on 5 point frequency scale (Never=0 to very often=5).

3. Program directors’ attitude towards ART was also modeled as a dependent variable.
For this survey, ART was defined as “a procedure based on removing carious tooth tissues using hand instruments alone and restoring the cavity with an adhesive restorative material”.

**Materials for study III**

Study I and II used self-reporting survey to investigate program directors’ didactic and clinical instruction on ART provided in their programs. This method evaluates one factor at a time, and does not assess the “derived decision” or relative importance of each factor \(^{14}\) conjoint. Simple ranking is susceptible to social desirability, failing to both incorporate any concept of opportunity cost and measure preference strength. To avoid those shortfalls, in study III, we used conjoint design to investigate factors driving pediatric dentists’ decision to use ART with their child’s patient. Conjoint analysis, which was developed originally in economic and marketing research, was based on the theory that decision options can be described by sets of attributes or factors, each made up of different levels. The relative value that professionals attach to different factors can be estimated by constructing a series of hypothetical scenarios made up of these factors at different levels and asking professionals patients to rate, rank, or make choices within a set of hypothetical options.

**Study survey instrument in study III**

A web-based questionnaire with 21 items was used in this study. The survey was pre-tested for content validity, using cognitive analysis by faculty members from the Department of Preventive and Community Dentistry and Department of Pediatric Dentistry, at the University of Iowa during spring of 2010. Pilot testing for face validity was carried out by six pediatric dentistry senior residents.

The questionnaire had 3 sections: (I) nine conjoint questions, (II) nine demographic and practice characteristics questions, and (III) three follow-up questions about the use of ART.
Conjoint questions

Each participant was presented with 9 patient scenarios; each scenario represented a specific scenario of a child patient with dental caries seeking restorative treatment. The clinical presentation of the dental caries in the nine patients’ scenario was fixed, in which all scenarios had the same carious lesion in an upper anterior primary tooth deep into the dentin but with no pulpal involvement evident clinically or radio-graphically. System and behavioral factors were manipulated in these scenarios to demonstrate non clinical factors that may influence the selection of ART as a treatment option.

Independent variables in study III

There were 9 independent variables used in the final model: Child’s age (age 2, 4 or 6); Level of child’s cooperation, (uncooperative moderately cooperative, cooperative); Child’s insurance coverage, (public insurance, private insurance or no insurance). Figure 3

Dependent variable in study III

For each patient scenario, pediatric dentists rated the likelihood to which they were willing to use ART on a 5-point scale, ranging from 5=”Very likely to use ART” to 1= “Very unlikely to use ART”.

Conjoint design

In this study we used an orthogonal fractional factorial, main effects design, to maintain information and statistical efficiency. This design, using principles of independence and balance, provides a subset of all possible combinations of characteristics and allows estimations of the relative weights (utilities) for each level of the presented factors on the willingness to use ART score.

Data Management in study I, II and III

For the three studies, data gained through the online survey software were exported directly to an Excel sheet accessible to the principal investigator under a protective password. Subjects’ names and personal information (e.g. address, emails…)
were kept confidential and attached to respondents by identifiers. These identifiers and associated data were stored and managed on a password secured server to prevent entry by unapproved individuals. The identifiers were used to assess the need for a second contact or future follow up and were deleted completely once analysis had been finalized. The data were exported into SPSS data files and the PASW SPSS Statistics 18 and SPSS Conjoint 18 were used to carry out the analysis.

Statistical analysis in study I, II and III

In study I and II, multiple linear regressions used to model the attitude of program directors towards ART and the level of clinical training provided on ART. Logistic regression was used to model the variable didactic instruction.

Variables that were included in the multivariable regression models were selected on the following basis, 1) significant at predetermined $\alpha$ level of 0.05 in bivariate analysis, 2) not highly correlated with other predictors and 3) did not have a skewed distribution. In addition, other variables were included on some well-known theoretical basis such as the influence of attitude on behavior.

Multicollinearity was checked in all regression models using correlation matrix, Tolerance test and Variance Inflation Factor (VIF).

In study III, conjoint utilities were estimated using the ordinary least squares (OLS) regression.

In the three studies, descriptive summary statistics included percentages, means, medians, and standard deviations, were calculated for both outcome and potential predictor variables. Associations among potential predictor variables in study I and II were also explored to exclude any possible predictor variables interrelationships.

The three following chapters will describe the three studies separately in details: Chapter 4: study I titled “Atraumatic Restorative Treatment (ART) in Pediatric Dentistry Residency Programs: A Survey of Program Directors”
Chapter 5: study II titled: “Does Atraumatic Restorative Treatment (ART) Have a Place in the US Dental Schools’ Curricula? A Survey of Pre-doctoral Pediatric Dentistry Programs”

Chapter 6: study III titled “The willingness of US pediatric dentists to use Atraumatic Restorative Treatment (ART) with their patients: A conjoint Analysis”
CHAPTER 4: ATRAUMATIC RESTORATIVE TREATMENT (ART) IN PEDIATRIC DENTISTRY RESIDENCY PROGRAMS: A SURVEY OF PROGRAM DIRECTORS

Abstract

Little data exist regarding the use of Atraumatic Restorative Treatment (ART) in Pediatric Dentistry residency programs in the US. This study investigated the extent of didactic instruction and clinical training on ART among pediatric dentistry residency programs and assessed program directors’ attitudes toward ART. All U.S. Pediatric Dentistry residency programs’ directors were asked to complete a web-based survey that was pretested for its face and content validity. Sixty-one of the 76 Directors (80%) completed the survey, with no significant response bias. Eighty-nine percent of the responding programs provided clinical instruction on ART. Of these, 30% provided this training often/very often. ART was used mostly in single-surface cavities (43%) and as an interim treatment in primary teeth (57%). Factors associated with directors positive attitude towards ART included believing that child’s caries risk ($P<.006$), professional guidelines ($P<.003$), and patient insurance status ($P<.04$) are important factors in selecting restorative treatment. Factors associated with ART training included not placing amalgams in primary teeth ($P<.03$) and having a director with positive attitude towards ART ($P<.001$). In general, programs with directors who had positive attitude towards ART were more likely to provide training on ART.

Introduction

Access to oral care is still problematic for certain populations in the US. Among the factors that limit access are the limited availability of services and inability to pay for services. To address such problems, strategies to make services more efficient, affordable and less traumatic have been suggested. Atraumatic Restorative Technique (ART) was
proposed as one solution to achieve those goals. ART was developed in the 1980s as an affordable, patient-friendly caries management procedure that does not need extensive operator training or special skills. A recent meta-analysis in 2010 showed that survival of ART restorations was 93% over 2 years in single surface restorations and 62% in multiple surface restorations in primary teeth. In permanent teeth, survival was 80% over 5 years in single surface restorations and 86% over one year in multiple surface restorations. Another meta-analysis in 2011 showed that when compared with amalgam, there was no significant difference between the two restorations after 12 and 24 months in primary teeth. In permanent teeth ART restorations survived better than amalgam for up to 6.3 years but survival was site-dependent; occlusal restorations had higher survival rate than occluso-proximal restorations. Those survival rates qualified ART to meet the American Dental Association specification for quality restorations, especially for single surface restorations.

The World Health Organization (WHO) recognizes ART as part of the basic package of oral care for all communities around the world. It views ART as an innovative highly effective approach suitable for populations at all levels of economic development. It also believes that ART fits modern concepts of preventive and restorative oral care, with stress on prevention and minimally invasive restorative care. As stated by the International Dental Federation (FDI): “The ART approach is consistent with modern concepts of preventive and minimally invasive restorative oral care. Importantly, pain and discomfort are rare during treatment, virtually eliminating the need for an anesthetic”.

Although the ART approach was initially developed to provide preventive and restorative care to people in low-income countries, the use of ART is no longer restricted to underprivileged nations. Burke et al. reported that nearly 10% of general dental practitioners in England and Scotland had adopted ART to treat children. In The Netherlands, ART was used by 26% of general dental practitioners, mainly to treat
children and anxious adults. Moreover, the 2006 Scottish Intercollegiate Guidelines Network report on prevention and management of dental decay in the preschool child, stated that “The use of ART for cavity preparation in carious primary teeth should be considered as an alternative, where appropriate, to conventional cavity preparation techniques”.

However, this is only one side of the story. In the Burk et al. study that assessed the use of ART in the UK, although 42% of the 390 general dental practitioners knew about ART, only 10% actually practiced it. Dr. Sarll, past president of the British Dental Association explained that those results might well be due to some dentists’ views that ART is “a way of legitimizing inferior care using rudimentary instruments and crude techniques”. Another explanation of the underuse of ART was posed by Ericson et al., who stated that “we have the means, motives and opportunities for minimal invasive dentistry (MID), but there may be lack of economic incentives as many reimbursement systems do not recognize MID procedures”, which include ART.

The use of ART in the U.S. is not as well-established or as well-studied. In the 2011 revision of its policy statements, the American Academy of Pediatric Dentistry (AAPD) recognized two different therapeutic types of ART; Interim Therapeutic Restorations (ITR) and the Atraumatic Restorative Technique (ART). These procedures have similar techniques but different therapeutic goals; both scoop out dental caries using hand instruments and placement of GI to restore the resultant cavity. However, ITR was recommended by AAPD to be used in very young patients, uncooperative patients, patients with special health care needs for whom traditional cavity preparation and/or placement of traditional dental restorations are not feasible or need to be postponed, as well as in children with multiple open carious lesions, prior to definitive restoration of the teeth. ART was defined by the AAPD as “a means of restoring and preventing caries in populations that have little access to traditional dental care and necessarily functions as definitive treatment”. In its most recent initiative to prevent Early
Childhood Caries (ECC), the Indian Health Service promoted the use of ITR and ART to reduce the need for children having to go to the operating room to receive dental treatment.\textsuperscript{145}

While recent recommendations and policy statements have advocated the use of ITR and ART, knowledge and use of these techniques may be lacking. For example, in a national sample that represented 43\% of pediatric dentists in 2001, 89\% restored teeth “aggressively with stainless steel crowns” and 51\% “cleaned caries by spoon and placed GI” when they were asked about the most frequent caries management techniques they usually used with children younger than three years old.\textsuperscript{146} In a similar study among general dental practitioners, 44\% of dentists in a 2005 survey often used ART as a restorative procedure to treat children; however, 38\% of the same sample had no knowledge about ART and 32\% thought that further training on ART was “not desirable”.\textsuperscript{147}

In a recent study that compared the use of MID techniques between civilian and federal service dentists, the largest percentage of reported “Some” knowledge of both ART and MID (36.6\%), while 13\% of respondents reported “No” knowledge for ART technique.\textsuperscript{148} Given the strong evidence of the great impact of dental education and training on future dentists’ attitude and behavior,\textsuperscript{149-152} the under use of ART may reflect that little attention is given to ART in dental education in general and in pediatric dentistry training programs in particular. However, very little is known about ART-related training in U.S. dental education.

The objectives of this study were 1) to assess factors related to the attitude of pediatric dentistry residency program directors towards ART; 2) to assess factors related to the didactic instruction of ART in pediatric dentistry residency programs in the US; and 3) to assess factors related to the level of clinical training on ART in pediatric dentistry residency programs in the US. By studying the level of didactic and clinical training on ART provided to future pediatric dentists and the attitude of program
directors towards this procedure and how it may influence the training provided, barriers can be identified and better efforts made to promote the use of alternative approaches to oral care, especially for those whom traditional care is inaccessible or impractical.

Methods

This was an observational, cross-sectional study of pediatric dentistry residency program directors in the US, using a pretested web-based questionnaire with 51 items. The survey was pre-tested for content validity, using cognitive analysis (consulting and pre-testing 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 at the University of Iowa during the spring of 2010. Pilot testing for face validity was carried out by two pediatric dentistry senior residents, and two dental public health senior residents.

Program directors of all seventy six pediatric dentistry residency programs identified by the American Academy of Pediatric Dentistry (AAPD) and accredited by the American Dental Association (ADA) as of May 2010 were invited to participate in this survey. Eligible programs included hospital-based, dental school-based and combined programs.

An invitation letter, signed by the principal investigator, research chairperson, and two members of the research team was mailed to all program directors in the first week of May 2010. The invitation letter explained the objectives of the study and gave a general idea about the nature and the number of the questions in the survey. After 7 days, an email including a cover letter which described confidentiality safeguards, the link to the web survey and a unique identification number was sent to all directors. Two reminder emails with the web survey link and the unique identifier number were sent again two and four weeks after the original email to those who did not submit the completed survey.
or did not opt out. A thank you email was sent to all participants. The University of Iowa Institutional Review Board (IRB) approved all aspects of this study.

The questionnaire was divided into five sections: (I) program directors' characteristics, (II) residency program characteristics, (III) the characteristics of the patient population served by the program, (IV) the attitude of program directors towards ART and (V) the level and format of didactic and clinical instruction on ART.

Besides the demographic characteristics of the program, section II included questions about the use of behavior management techniques in the program (2 questions), and the use of different Minimal Invasive Techniques (MID) in the program (11 questions). The key independent variables included in the analyses were program director’s age, gender, number of years since graduation, the type of program affiliation (hospital, dental school, or community-based), frequency of the use of different behavior management techniques used with children younger and older than 3 years old (non-pharmacological, protective stabilization, nitrous oxide, sedation, general anesthesia), frequency of the use of amalgam in the program (primary teeth and permanent teeth), the use of MID techniques in the program (composite variable, described below), and program director’s attitude towards ART (composite variable, described below). Figure 1 shows the conceptual framework of the variables in this study.

The composite variable, the use of MID techniques, included 11 MID procedures that were agreed on during the cognitive analysis phase of questionnaire development. The scale was the sum of responses to the 11 questions each measured on a five-point frequency scale (never =1, rarely, 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 = 38 (± 6) in our study sample. For this scale, a respondent who scored “never” all the time would have a total score of 11 and the respondent who scored “most often” all the time would have a total score of 55 (Table 1).
The composite variable regarding Program directors’ attitude towards ART was used as an intermediate variable in our model (acted both as a predictor and outcome variables). The agreement or disagreement of program directors with 10 statements about ART was measured on a five-point Likert scale. The scale summed the scores for each sub-question, 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 0.8 and the mean for the study sample was 37 ±7 (Table 2).

Didactic instruction and level of clinical training provided on ART were the key dependent variables for this study. Program directors’ attitude towards ART was also modeled as a dependent variable. Didactic instruction was measured by the question “Does your program’s didactic instructions teach that preparing cavities using only hand instruments can be a proper technique in certain situations?” and the response was dichotomized as Yes or No.

The Level of clinical training provided on ART was measured by the question “How often do the pediatric dentistry residents use ART as a caries management technique for their patients?”. Response were measured on 5 point frequency scale (Never=0 to very often=5). For this survey, ART was defined as “a procedure based on removing carious tooth tissues using hand instruments alone and restoring the cavity with an adhesive restorative material”.

Data Management

Data gained through the online survey software were exported directly to an Excel spreadsheet accessible to the principal investigator under a protective password. Subjects’ names and personal information (e.g. address, emails…) were kept confidential and attached were matched to respondents by unique identifiers. These identifiers and associated data were stored and managed on a password secured server to prevent entry by unapproved individuals. The identifiers were used to assess the need for a second
contact or future follow up. These identifiers were deleted completely once analysis had
been finalized. The data were exported into SPSS data files and the PASW Statistics 18
was used to carry out the analysis.

Statistical analysis

Statistical analyses included descriptive statistics, bivariate analyses and
multivariable modeling. Descriptive summary statistics included percentages, means,
medians, and standard deviations, with respect to both outcome and potential explanatory
variables. Associations among potential explanatory variables were also explored to
exclude any possible predictor variables interrelationships.

The bivariate analyses were conducted to consider associations between our
outcome variables (dependent variables) and each potential predictor variable
(independent variables). The three main outcome (attitude towards ART, didactic
instruction, and clinical training) variables were measured at ratio, nominal, and ordinal
scales, respectively. Explanatory variables were mainly measured at ordinal and ratio
scale and some were nominal. Standard χ² tests of independence, or Fisher exact tests if
needed, were used to evaluate possible relationships among pairs of nominal categorical
variables. Spearman’s rank test was used to assess associations between a ratio response
and ordinal response, between two ordinal responses or between two ratio responses; for
example, between age and a composite score (attitude scale). Mann-Whitney tests and
Kruskal Wallis tests were used to assess associations between nominal predictor variables
and ordinal or ratio responses.

Variables that demonstrated statistically significant differences in the bivariate
analysis (p ≤ 0.05), had response distribution around 50% and did not correlate with other
predictor variables (rho > 0.5) were used to develop the most parsimonious multivariable
models. 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. Additionally, possible statistical interactions between the predictor variables were examined. 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 a 0.05 level of statistical significance.

**Results**

The overall response rate for this study was 80%, with 61 programs out of 76 responding. Respondent and non-respondent programs were compared in a descriptive way according to variables obtained from AAPD programs’ profile such as location of the primary site of the program, affiliation of the program, number of residents accepted in the first year, programs having full or part time directors, directors’ board certification, number of faculty members in the program and stipend provided. No response bias was detected based on these comparisons.

**Program Directors’ Characteristics**

Sixty-one percent of respondents were male. The mean age of respondents was 53 years (range 32 to 75 years), and the mean number of years since graduation was 29 years (range 8 to 46 years). Eighty-seven percent had graduated from a US dental training program and 60% completed their training in hospital-based programs. Ninety percent of the program directors who responded to this survey were board certified and 49% had other post DMD/DDS training or degrees.

Respondents devoted a mean of 41% of their time to teaching and student supervision and 9% to research (Table 3). When discussing restorative treatment options with their residents, 99% of program directors cited children’s caries risk as “very important” or “important”, 77% cited parental preference as “very important” or “important” and only 38% cited patient insurance status or source of payment as “very important” or important.

Approximately 92% of program directors reported that continuing education was “very influential” or “influential” on their knowledge regarding different restorative
options, and 84% cited post-doctoral training as a “very influential” or “influential” source.

**Program Characteristics**

Thirty respondent programs were dental school based, 30 were hospital based and one program was based in public health or community center. Fifty-two programs were located in urban areas, with 39 programs located in inner cities.

Non pharmacological behavior management techniques were used by 75% and 85% “very often” or “often” with children three or younger and with children older than three years respectively. On the other hand, 79% of the programs used general anesthesia “very often” or “often” with children three years or younger and 52% used it “very often” or “often” with children older than three years.

Of the overall clinical training experience in respondents’ programs, a mean time of 34% was spent on-site dental schools, 38% in affiliated hospital dental clinics, 15% in operating rooms and 4% in off-site public health clinics.

Patient population served by the program characteristics A mean of 74% (74% ±13) of the patient population served by respondent programs were at high caries risk and (20 ±11) were at low caries risk. About (77% ±20) of respondent programs patients were covered by Medicaid and other public insurance, (11%±10) by private insurance and (10% ±11) were covered by no insurance.

The mean age distribution of children treated by respondents programs were as follows; (24% ±10) younger than 3 years, (37%±11) aged 3-5 years, (27%± 11) aged 6-12 years and (12 % ±8) aged 13 years and older. Twenty-one percent (21% ± 13) of the respondent programs treated children with Intellectual and Developmental Disabilities (IDD).

**Attitude of Program Directors towards ART**

Respondents selected responses to 9 statements about ART that measured their attitudes toward ART (Table 2). The scale was measured by summing scores of the five
point agreement likert scales (5 = strongly agree to 1 = strongly disagree) for each of the ten statements of attitudes. For this sample of 61 program directors, the mean score was 37 ± 7 with a range from 9 to 49, where higher values indicated more positive attitudes toward ART.

Bivariate analysis showed that directors who thought that continuing education was a very important source of their knowledge about different restorative options, and directors who thought a child’s age, behavior and caries risk, professional guidelines, and patient insurance were very important when discussing different treatment options with their residents had more positive attitudes towards ART.

On the contrary, programs that used G.V. Black “extension for prevention principle” and placed “amalgam in primary teeth” more often had directors with more negative attitudes towards ART (Table 4).

In the final regression model of the scale variable “Attitude towards ART”, five variables stayed significant and explained 45% ($R^2 = 0.447$, $F= 7$, $P$ value= .012) of the variation of program directors’ attitudes towards ART (Table 5).

**Didactic Instruction Provided On ART**

The assessment of didactic instruction in ART in pediatric dentistry residency programs consisted of two sub questions: “Does your program provide any didactic instruction in ART in your curriculum?” and “Does your program's didactic instruction teach that preparing cavities using only hand excavators can be a proper technique in certain situations?” The latter question was used as the outcome variable for bivariate and modeling analysis. The majority of respondents (90 %) selected “yes” for the first question and 86.7 % selected “yes” for the second question. Most of the didactic instruction was in the format of “Assigned readings” (87%), “Small group discussion” (85 %), “Lecture” (82%), “Case-based learning” (71 %), “Handouts” (49 %), and “Video presentation” (7 %).
Table 6 shows the bivariate analysis results for the outcome variable “Didactic instruction on ART”. A logistic regression model was performed to assess the impact of the predictor variables on the likelihood that respondents taught their residents that “preparing cavities using only hand excavators can be a proper technique in certain situations”. This model contained 4 independent variables, directors who strongly disagree with the statement “Leaving caries in the floor of a prepared cavity is never justified”, the proportion of children age 6 to 12 treated by the program, the proportion of children with IDD treated by the program, and the use of pharmacological behavioral management technique such as sedation and general anesthesia. The full model containing all predictors was statistically significant $\chi^2 = 20$, $p<.001$, indicating that the model was able to distinguish between respondents who reported and did not report teaching that “preparing cavities using only hand excavators can be a proper technique in certain situations”. The model as a whole explained between 30% (Cox and Snell R square) and 53% (Negelkerke R squared) of the variance in didactic instruction on ART, and correctly classified 89.3% of cases. However, as shown in table 7 and due to the small sample size, no single variables made a unique statistically significant contribution to the model.

**Level of Clinical Training Provided on ART**

Although 89% of program directors stated that they provide clinical instruction on ART for their residents, only 30% used this technique “very often” or “often” as a caries management technique for their pediatric patients. Table 8 shows the types of ART used by pediatric dentistry residents in the US. ART seems 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 (63%) and in anterior teeth (74%). Amalgam was “rarely” or “never” used in posterior teeth (97%).
Among the 12% who answered “No” to the question “Does your program provide clinical instruction on ART, as defined above,” 5% cited “Residents should learn ideal restorations first “as a reason for not including ART in their training programs. Other reasons cited were “No special ADA code exists to reimburse ART restorations” (3%), “ART is a sub optimum treatment” (3%), and “Insufficient scientific evidence that supports the use of ART” (3%).

Bivariate analysis for the dependent variable “level of clinical training on ART” is shown in table 9. In multiple linear regressions, four predictor variables, attitude toward ART composite variable, the use of MID composite variable, frequency of the use of general anesthesia with children 3 years or younger and placing amalgam in primary teeth more often, remained significant in the final model (Table 10). Those variables explained 50% of the variation in the level of clinical training provided in those programs.

Discussion

This study used an online survey sent to the 76 pediatric dentistry residency program directors identified by the AAPD and verified by the American Dental Association (ADA) in 2010. The list included United States residency programs based in dental schools, hospitals, and community centers. The response rate of 80% was considered to be high, suggesting that the findings may be generalized to all training programs. Moreover, no response bias was found between respondent programs and non-respondents programs when they were compared on program characteristics obtained from the AAPD program profiles website, which further suggests that our sample was representative of all pediatric dentistry residency programs in the US. However, we cannot claim the representativeness of the program directors themselves because we did not directly compare the characteristics of the directors.

The results revealed that 88.5% of the programs provided clinical instruction on ART; however, only 30% used this procedure “often” or “very often” and 22% used it
“rarely” or “never “as a caries management technique. In comparison, another study that was conducted in 2003 showed that 36% of a national sample of dental practitioners received hands-on training on ART and 38% received none. In the same previous study, 44% of general dental practitioners cited the use of ART in their current practices “often” or “very often” and 28% used it “rarely” or “never”. Among pediatric dentists, a national study conducted in 2001 showed that 51% of pediatric dentists “cleaned caries by spoon and placed GI” for children younger than three years old.

Although most of the early studies used ART in permanent teeth and as a definitive treatment, our study showed that the main use of ART in pediatric residency programs in the US was in primary teeth and as an interim treatment. This may be explained by the multiple revisions of the AAPD policies and guidelines on the use of ART. 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”. In a 2008 revision, the AAPD gave the procedure another name, ITR, which is the same technique as ART; however, the therapeutic goal for ITR was limited to “a beneficial provisional technique in contemporary clinic for young children, uncooperative children and for children with multiple carious lesions prior to definitive treatment”. Thus, AAPD endorsed the interim version of ART in modern dental practice.

The results of the present study showed that Pediatric Dentistry residency programs used ART more in anterior teeth than posterior teeth. Regarding to the dental materials used in those programs in general, our study reported that 28% of the programs used GI in posterior primary teeth with pediatric patients, 28% used amalgam and 73% used composite based materials “often” or “very often”. In posterior permanent teeth the use of GI is even less; our results showed that 5% of the programs used GI “often” or “very often”, 25% used amalgam, 82% used composite based materials and 23% still use G.V. Black’s design in preparing their cavities “often” or “very often”. Those results agree with a 2001 national survey of pediatric dentists where 95% of the sample indicated
the use of definitive treatment modalities in posterior teeth in enamel and dentine lesions and only 40% used GI.\textsuperscript{146} In another study conducted in Florida in 2002, 63 % of pediatric dentists used amalgam in restoring posterior primary teeth, 57% used hybrid composite, and 6% used GI.\textsuperscript{161}

The highest survival rate for ART in the literature\textsuperscript{137,162} was for single surface when resin modified GI (RMGI) was used. This kind of restoration meets the ADA specification for quality restorations.\textsuperscript{163} Our study showed that 70 % of the programs used RMGI “very often” or “often” compared to 33% who used conventional GI. And as expected, 44 % of the programs used ART in single surface in primary teeth “very often” or “often” while only 15 % used it multiple surfaces restorations “often” or “very often”.

Ninety percent of the programs responded with “Yes” to providing didactic instruction on ART for their residents and 87% said “Yes” when they were asked if they provided didactic instruction “that preparing cavities using only hand excavators can be a proper technique in certain situations”. In spite of the high response rate, the small sample number and skewed response distribution in this study limited the analysis of the dichotomized outcome variable “didactic instruction”. The whole model predicted 30% to 53% of the odds to provide didactic instruction on ART. The strongest predictor was the disagreement of program directors with the statement “Leaving caries in the floor of a prepared cavity is never justified”. Although researchers who endorse the use of ART encourage the removal of all infected tissues from the floor of the cavity, they suggest that applying GI may arrest the residual activity in any inadvertently remaining infected dentin.\textsuperscript{164}

The use of pharmacological behavior management techniques such as nitrous oxide, sedation and general anesthesia with children younger than 3 was another predictor of increased the odds to provide didactic instruction on ART. This combined predictor also was significant in predicting the level of clinical training on ART provided in those programs.
Finally, programs with a high proportion of children with Intellectual and developmental Disabilities (IDD) seem to encourage more didactic instruction on ART. Professional and global health organizations encouraged the use of ART in modern clinical settings especially for children with intellectual and developmental disabilities.\textsuperscript{165} However, this predictor was significant with the variable “didactic instruction”; it was not significant with the variable “level of clinical training on ART”.

When the association between predictor variables and the outcome variable “level of clinical instruction on ART” was assessed, four variables remained significant in the final regression model and explained 50\% of the variation in the level of training provided.

The “use of MID procedures” scale explained 28 \% of the variation in our outcome variable. This was expected because ART is considered one of the pillars of MID philosophy (166) and the programs that used MID “more often” are expected to be more inclined to use ART more frequently.

The second variable that also explained 28 \% of the variation in the outcome was the use of general anesthesia (GA) as a behavioral management technique for children three years or younger. This could be explained by two reasons: first, programs that use GA more often with very young children seem to operate within a high caries risk population which in turn encourages the use of ART. Or, second, programs may use ART as a caries stabilization technique until young children can be admitted to the operating room.

The third variable that explained 23 \% of the variation in the level of ART training was placing amalgam in primary teeth. This time the relationship was inverse: programs that placed amalgam restorations in primary teeth more often also used ART less often as a caries management technique with children. This agrees with results from 2001 national survey, where 96\% of pediatric dentists used definitive treatments such as amalgam and stainless steel crowns for all types of lesions, while only 30 \% used GI for
the same lesions. After controlling for other variables, attitude toward ART scale alone explained 35% of the level of training on ART. This was expected within the frame of the well-known influence of attitude on behavior and training provided to students as cited by other literature.

The program directors’ attitudes toward ART was measured using a scale and its distribution was skewed towards a more positive attitude, where only 4 program directors scored less than 27 on the scale (the scale ranges from 10 as the worst to 50 as the best) and 22 directors scored between 40 and 50 on the same scale. However, our results showed 38 directors scored between 10 and 40 on the attitude scale, which indicates that most of the directors are more neutral towards ART. This appears to be in the line with the results of a national survey in United Kingdom in 2005 which showed that although almost half of the respondents were aware of the ART technique and although most prepared cavities that were presented to respondents in the questionnaire were good candidates to be minimally invasive preparations and appropriate for ART, few selected ART as a caries management technique. However, in the US recent studies in 2006 and 2009 showed more positive attitudes towards MID in general and to towards ART in particular among civilian, federal and public health dentists.

Five predictor variables in the final model explained 45% of the variation in the attitude of program directors towards ART. This result considered high given our knowledge of the difficulty to explain attitude in general. Strong predictors for program directors’ attitude were the belief that a child’s caries risk, professional guidelines and patient’s insurance status are very important factors in restorative treatment modalities’ selection. Professional guidelines were usually rated in different surveys of pediatric dentists as an important source of knowledge about different treatment modalities and although the AAPD guidelines gave ART another name and endorse it only as interim restoration, it encourages its use with very young, uncooperative or high caries risk children. In addition, tailoring treatment plans
according to a child’s caries risk assessment is an important component of MID philosophy; therefore, directors with a positive attitude toward MID will have a positive attitude toward both the importance of risk assessment and the use of ART. Patients’ insurance status has been identified as an important factor in selecting a restorative treatment option for children.\textsuperscript{146,147,170} In a 2001 survey of a national sample of pediatric dentists, respondents indicated that certain restorative modalities are more effective with Medicaid patients than others.\textsuperscript{146} Thus, a program that has the majority of its population covered by particular insurance status may influence the attitude of the program directors towards certain procedures that may be more feasible with certain payment types.

Moreover, program directors 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 was in the US toward definitive restorations as the treatment of choice,\textsuperscript{147} currently many dental practitioners have started to believe in less invasive procedures, especially in pediatric dentistry.\textsuperscript{148,168}

The final predictor which predicted both attitude and level of ART training provided (inverse relationship), is “placing amalgam in primary teeth”. This variable indicates the use of a more definitive restoration policy and less minimal invasive philosophy.

Program directors who did not provide any training on ART in their programs justified that for different reasons. The most cited reasons were, 1) “residents should learn ideal restorations first” which indicates that they view ART as a sub-standard treatment; similar comments from respondents that reflected the negative attitude towards ART were: “not a big deal”, “not needed as a treatment” and “It is a treatment option for general practitioners and not for specialists”. 2) “No special ADA code exists to reimburse ART restorations”, which reflect the attitude that if ART needs to be marketed as an affordable treatment among pediatric and general dentists, the first step is to add a
special code for ART that makes it feasible to obtain reasonable reimbursement for this procedure.

This study was the first of its kind to survey program directors about their attitudes towards ART and the didactic and clinical instruction provided to residents in pediatric dentistry residency programs in the United States. Although we had a high response rate of 80%, the small size for this population, (76 programs in 2010) posed some difficulties in statistical analysis.

Another limitation of this study was the inability to survey all pediatric dentistry faculty members in the program; program directors may not be fully aware of the curriculum details and what happened in the clinics on a daily basis. However, including more faculty members from the same institution would complicate the analysis because the independence of observations would become an issue.

Although we placed questions about ART only near the end of the survey, to avoid arousing certain attitudes or pre-judgment about ART, social desirability cannot be excluded as a factor that may under or overestimate the level of training and didactic instruction provided.

This survey shares with all other survey research the limitation of cross-sectional data, the difficulty in proving directionality in the associations between predictor and outcome variables, and restrictions on the number of questions asked to maximize response rate. However, using online access with mail invitation letters for this population was an important factor in the high response rate.

In this study, the multivariable model explained 50% of the variation in the level of clinical training provided on ART and 45% of the variation in the attitude of program directors towards ART, this means there are still more variables need to be explored that influence the attitude and behavior of program directors. Future studies may consider reviewing programs’ curricula and clinic charts, surveying students and residents in their final year, and surveying practitioners and specialists working in pediatric dentistry
practices. This may give us a better idea about the use of ART in the US, factors related to this use, and the attitude of practitioners towards ART. Reviewing clinical charts maybe difficult, especially if no special code for ART is used, but some proxy measures may be used such as procedures that use GI without local anesthesia.

Conclusions

Eighty eight percent of Pediatric Dentistry Residency programs in the US provided clinical training on ART; however only 30% of those programs used ART “Very Often/ Often” as a caries management technique for their pediatric patients. Pediatric Dentistry residency programs used ART mainly in primary, anterior, single surface cavities and as interim treatment.

Attitudes toward ART alone and with control of other variables explained 35% of the level of training on ART. Professional guidelines and insurance coverage were two of the strongest predictor of program director attitude.

Professional guidelines and insurance coverage were two of the strongest predictor of program director attitude. Therefore, the first steps to gain further acceptance of the use of ART by training programs, practicing dentists, third party payers, and educational institutions, are 1) professional organization should emphasize the good evidence behind this technique and 2) third party payers should include special code for ART as an affordable treatment.
Figure 1 Conceptual Model of Study I
<table>
<thead>
<tr>
<th>Attitude statements</th>
<th>Strongly agree % (n)</th>
<th>Somewhat agree % (n)</th>
<th>Neither agree nor disagree % (n)</th>
<th>Somewhat disagree % (n)</th>
<th>Strongly disagree % (n)</th>
<th>Total % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ART restorations can be used as a caries stabilization method</td>
<td>59 (36)</td>
<td>37 (23)</td>
<td>0 (0)</td>
<td>2 (1)</td>
<td>2 (1)</td>
<td>100% (61)</td>
</tr>
<tr>
<td>ART cannot be considered as a definitive treatment under any circumstances</td>
<td>15 (9)</td>
<td>20 (12)</td>
<td>13 (8)</td>
<td>36 (22)</td>
<td>16 (10)</td>
<td>100% (61)</td>
</tr>
<tr>
<td>ART could help in addressing problems related access to oral care</td>
<td>36 (22)</td>
<td>42 (26)</td>
<td>12 (7)</td>
<td>7 (4)</td>
<td>3 (2)</td>
<td>100% (61)</td>
</tr>
<tr>
<td>ART does not meet the standard of care in the US</td>
<td>8 (5)</td>
<td>25 (15)</td>
<td>13 (8)</td>
<td>39 (24)</td>
<td>15 (9)</td>
<td>100% (61)</td>
</tr>
<tr>
<td>ART can be a good option for high caries risk children with multiple cavitated carious lesions</td>
<td>34 (21)</td>
<td>43 (26)</td>
<td>13 (8)</td>
<td>8 (5)</td>
<td>2 (1)</td>
<td>100% (61)</td>
</tr>
<tr>
<td>ART is not suitable for use in children with IDD</td>
<td>7 (4)</td>
<td>8 (5)</td>
<td>10 (6)</td>
<td>41 (25)</td>
<td>34 (21)</td>
<td>100% (61)</td>
</tr>
<tr>
<td>ART can be effective in treating very young children</td>
<td>55 (34)</td>
<td>33 (20)</td>
<td>8 (5)</td>
<td>0 (0)</td>
<td>2 (1)</td>
<td>98% (60)</td>
</tr>
<tr>
<td>ART can be a valid treatment option for children with limited financial resources</td>
<td>28 (17)</td>
<td>25 (15)</td>
<td>28 (17)</td>
<td>16 (10)</td>
<td>3 (2)</td>
<td>100% (61)</td>
</tr>
<tr>
<td>ART should be modified to conform with the oral health care standards in the US</td>
<td>15 (9)</td>
<td>16 (10)</td>
<td>51 (31)</td>
<td>15 (9)</td>
<td>3 (2)</td>
<td>100% (61)</td>
</tr>
<tr>
<td>Applying ART sealants adds a preventive dimension to the ART restorative care</td>
<td>5 (3)</td>
<td>12 (7)</td>
<td>39 (24)</td>
<td>28 (17)</td>
<td>15 (10)</td>
<td>100% (61)</td>
</tr>
</tbody>
</table>

Table 1 Distribution of Responses to Questions Regarding Frequency of Use of Selected MID Procedures among Pediatric Dentistry Residents
<table>
<thead>
<tr>
<th>MID procedures</th>
<th>Never % (n)</th>
<th>Rarely % (n)</th>
<th>Sometimes % (n)</th>
<th>Often % (n)</th>
<th>Very often % (n)</th>
<th>Total % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placing sealants in incipient carious fissures in permanent teeth</td>
<td>5 (3)</td>
<td>15 (9)</td>
<td>24 (15)</td>
<td>28 (17)</td>
<td>28 (17)</td>
<td>100 (61)</td>
</tr>
<tr>
<td>Placing sealants in incipient carious fissures in primary teeth</td>
<td>15 (9)</td>
<td>30 (18)</td>
<td>26 (16)</td>
<td>21 (13)</td>
<td>7 (4)</td>
<td>99 (60)</td>
</tr>
<tr>
<td>Placing sealants in minimally cavitated lesions in permanent teeth</td>
<td>33 (20)</td>
<td>28 (17)</td>
<td>24 (15)</td>
<td>10 (6)</td>
<td>5 (3)</td>
<td>100 (61)</td>
</tr>
<tr>
<td>Using tunnel approach in primary or permanent teeth</td>
<td>34 (21)</td>
<td>46 (28)</td>
<td>16 (10)</td>
<td>2 (1)</td>
<td>2 (1)</td>
<td>99 (60)</td>
</tr>
<tr>
<td>Placing glass-ionomer restorations in anterior primary teeth</td>
<td>2 (1)</td>
<td>7 (4)</td>
<td>39 (24)</td>
<td>36 (22)</td>
<td>16 (10)</td>
<td>100 (61)</td>
</tr>
<tr>
<td>Placing glass-ionomer restorations in posterior primary teeth</td>
<td>2 (1)</td>
<td>16 (10)</td>
<td>53 (32)</td>
<td>15 (9)</td>
<td>13 (8)</td>
<td>99 (60)</td>
</tr>
<tr>
<td>Placing composite-based restorations in anterior primary teeth</td>
<td>0 (0)</td>
<td>2 (1)</td>
<td>15 (9)</td>
<td>34 (21)</td>
<td>46 (28)</td>
<td>93 (56)</td>
</tr>
<tr>
<td>Placing composite-based restorations in posterior primary teeth</td>
<td>0 (0)</td>
<td>7 (4)</td>
<td>20 (12)</td>
<td>32 (20)</td>
<td>41 (25)</td>
<td>93 (56)</td>
</tr>
<tr>
<td>Placing composite-based restorations in posterior permanent teeth</td>
<td>0 (0)</td>
<td>2 (1)</td>
<td>16 (10)</td>
<td>36 (22)</td>
<td>46 (28)</td>
<td>100 (61)</td>
</tr>
<tr>
<td>Placing preventive resin restorations in primary teeth</td>
<td>7 (4)</td>
<td>12 (7)</td>
<td>20 (13)</td>
<td>30 (18)</td>
<td>30 (18)</td>
<td>99 (60)</td>
</tr>
<tr>
<td>Placing preventive resin restorations in permanent teeth</td>
<td>7 (4)</td>
<td>5 (3)</td>
<td>15 (9)</td>
<td>31 (19)</td>
<td>42 (26)</td>
<td>100 (61)</td>
</tr>
</tbody>
</table>

Table 2 Distribution of Responses to Questions Regarding Agreement or Disagreement to 10 Statements that described Attitude of Program Directors towards ART
<table>
<thead>
<tr>
<th>Program director characteristics</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>53</td>
<td>54</td>
<td>12</td>
<td>32</td>
<td>75</td>
</tr>
<tr>
<td>Number of years spent in the following settings before becoming a program director:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private practice</td>
<td>8</td>
<td>3</td>
<td>10</td>
<td>-</td>
<td>40</td>
</tr>
<tr>
<td>Academics (Full time faculty)</td>
<td>8</td>
<td>5</td>
<td>8</td>
<td>-</td>
<td>95</td>
</tr>
<tr>
<td>Public Health Service</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>Military dental corps</td>
<td>0.41</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>Percentage of time per week spent in each of the following in the past 12 months:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td>9%</td>
<td>5%</td>
<td>11%</td>
<td>-</td>
<td>60%</td>
</tr>
<tr>
<td>Administration</td>
<td>30%</td>
<td>30%</td>
<td>17%</td>
<td>5</td>
<td>100%</td>
</tr>
<tr>
<td>Direct patient care</td>
<td>21%</td>
<td>20%</td>
<td>19%</td>
<td>-</td>
<td>95%</td>
</tr>
<tr>
<td>Teaching/ student supervision</td>
<td>41%</td>
<td>40%</td>
<td>21%</td>
<td>-</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 3 Respondents Pediatric Dentistry Programs directors’ characteristics
Table 4 Results of Bivariate analysis Using Spearman Rank Correlation test of the Attitude of Program Directors towards ART Composite Variable and Selected Predictor Variables

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Spearman Rank Correlation coefficient</th>
<th>Significant value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directors coming from military dental corps background</td>
<td>Rho = 0.312</td>
<td>0.014</td>
</tr>
<tr>
<td>Directors who think that continuing education is a very important source of their</td>
<td>Rho = 0.286</td>
<td>0.025</td>
</tr>
<tr>
<td>knowledge about different restorative options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Directors who think that child’s age and behavior are very important factors when</td>
<td>Rho = 0.271</td>
<td>0.035</td>
</tr>
<tr>
<td>discuss different treatment options with their residents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Directors who think child’s caries risk is a very important factor when discuss</td>
<td>Rho = 0.311</td>
<td>0.015</td>
</tr>
<tr>
<td>different treatment options with their residents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Directors who strongly disagree with the statement “Definitive treatment should be</td>
<td>Rho = 0.453</td>
<td>0.000</td>
</tr>
<tr>
<td>always the treatment of choice”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Directors who strongly agree with the statement “Placing fissure sealant on</td>
<td>Rho = 0.411</td>
<td>0.001</td>
</tr>
<tr>
<td>incipient caries is a valid practice”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Directors who strongly disagree with the statement “Leaving caries in the floor of</td>
<td>Rho = 0.325</td>
<td>0.011</td>
</tr>
<tr>
<td>the prepared cavity is never justified”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programs that use of Nitrous oxide as a behavioral management technique for</td>
<td>Rho = 0.411</td>
<td>0.001</td>
</tr>
<tr>
<td>children three years or younger more often</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programs that use of Nitrous oxide as a behavioral management technique for</td>
<td>Rho = 0.316</td>
<td>0.013</td>
</tr>
<tr>
<td>children three years or younger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programs that have high % of patients covered by Medicaid</td>
<td>Rho = -0.272</td>
<td>0.036</td>
</tr>
<tr>
<td>Programs that have high % of patients covered by &quot;No insurance&quot;</td>
<td>Rho = 0.286</td>
<td>0.028</td>
</tr>
<tr>
<td>Programs that use G.V. Black “extension for prevention principle” more often</td>
<td>Rho = -0.027</td>
<td>0.033</td>
</tr>
<tr>
<td>Programs that use MID procedures more often</td>
<td>Rho = 0.261</td>
<td>0.042</td>
</tr>
<tr>
<td>Predictor variable</td>
<td>Beta Coefficient</td>
<td>p-value</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------------</td>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Directors who think child’s caries risk is a very important factor when discuss different treatment options with their residents</td>
<td>.32</td>
<td>.005</td>
</tr>
<tr>
<td>Directors who strongly disagree with the statement “Definitive restorations should be the treatment of choice regardless of other factors”</td>
<td>.33</td>
<td>.003</td>
</tr>
<tr>
<td>Directors who think that patient insurance status is a very important factor when discuss different treatment options with their residents</td>
<td>.22</td>
<td>.04</td>
</tr>
<tr>
<td>Directors who think that professional guidelines and standard of care are very important factors when discuss different treatment options with their residents</td>
<td>.35</td>
<td>.003</td>
</tr>
<tr>
<td>Programs that place amalgam in primary teeth more often</td>
<td>-.29</td>
<td>.012</td>
</tr>
</tbody>
</table>

\[ R \text{ square}=0.45; \; F=6.7, \; p<0.012 \text{ (Using the stepwise method and confirming the results with forward and backward regression)} \]

Table 5: Results of Multiple Linear Regression of the Attitude of Program Directors towards ART Composite Variable
Table 6 Results of Bivariate analysis of the Variable Didactic Instruction on ART Provided to Residents in Pediatric Dentistry Residency Programs and Selected Independent variables

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Statistical test</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directors who strongly disagree with the statement &quot;Leaving caries in the floor of a prepared cavity is never justified&quot;</td>
<td>Linear by linear association= 4.14</td>
<td>.041</td>
</tr>
<tr>
<td>Programs that have high proportion of children age 6 to 12 treated by the program, provided didactic instruction on ART more often</td>
<td>Mann-Whitney U test=92</td>
<td>.041</td>
</tr>
<tr>
<td>Programs that have high proportion of children with IDD treated by the program, provided didactic instruction on ART more often</td>
<td>Mann-Whitney U test=55</td>
<td>.001</td>
</tr>
<tr>
<td>Programs that use Nitrous oxide as a behavioral management technique for children three years or younger more often, provided didactic instruction on ART more often</td>
<td>Mann-Whitney U test=108</td>
<td>.023</td>
</tr>
<tr>
<td>Programs that use sedation as a behavioral management technique for children three years or younger more often, provided didactic instruction on ART more often</td>
<td>Mann-Whitney U test=119</td>
<td>.043</td>
</tr>
<tr>
<td>Predictor variables</td>
<td>B</td>
<td>p-value</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------------</td>
<td>-------</td>
<td>---------</td>
</tr>
<tr>
<td>Directors who strongly disagree with the statement “Leaving caries in the floor of a prepared cavity is never justified”</td>
<td>.611</td>
<td>.125</td>
</tr>
<tr>
<td>Proportion of children age 6 to 12 treated by the program</td>
<td>-.039</td>
<td>.378</td>
</tr>
<tr>
<td>Proportion of children with IDD treated by the program</td>
<td>.134</td>
<td>.117</td>
</tr>
<tr>
<td>The use of pharmacological behavioral management technique such as sedation and general anesthesia*</td>
<td>.294</td>
<td>.270</td>
</tr>
</tbody>
</table>

Table 7 Results of Logistic Regression of the Variable Didactic Instruction on ART Provided to Residents in Pediatric Dentistry Residency Programs.

*This is a combined variable

Cox and Snell R square = 30%, and Nagelkerke R² = 53%, In Omnibus test of Model fit, X² = 19.6, p<.001
<table>
<thead>
<tr>
<th>Types of ART used in the pediatric dentistry residency programs</th>
<th>Never % (n)</th>
<th>Rarely % (n)</th>
<th>Sometimes % (n)</th>
<th>Often % (n)</th>
<th>Very often % (n)</th>
<th>Total % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ART in anterior primary teeth</td>
<td>0 (0)</td>
<td>5 (3)</td>
<td>25 (15)</td>
<td>27 (17)</td>
<td>30 (18)</td>
<td>87 (53)</td>
</tr>
<tr>
<td>ART in anterior permanent teeth</td>
<td>13 (8)</td>
<td>39 (24)</td>
<td>33 (20)</td>
<td>2 (1)</td>
<td>0 (0)</td>
<td>87 (53)</td>
</tr>
<tr>
<td>ART in posterior primary teeth</td>
<td>2 (1)</td>
<td>20 (12)</td>
<td>41 (25)</td>
<td>13 (8)</td>
<td>10 (6)</td>
<td>86 (52)</td>
</tr>
<tr>
<td>ART in posterior permanent teeth</td>
<td>16 (10)</td>
<td>44 (27)</td>
<td>24 (14)</td>
<td>3 (2)</td>
<td>0 (0)</td>
<td>87 (53)</td>
</tr>
<tr>
<td>ART in single-surface cavities in primary teeth</td>
<td>2 (1)</td>
<td>8 (5)</td>
<td>39 (24)</td>
<td>22 (13)</td>
<td>16 (10)</td>
<td>87 (53)</td>
</tr>
<tr>
<td>ART in a single-surface cavities in permanent teeth</td>
<td>15 (9)</td>
<td>38 (23)</td>
<td>31 (19)</td>
<td>3 (2)</td>
<td>0 (0)</td>
<td>87 (53)</td>
</tr>
<tr>
<td>ART in multi-surface cavities in primary teeth</td>
<td>16 (10)</td>
<td>33 (20)</td>
<td>25 (15)</td>
<td>3 (2)</td>
<td>10 (6)</td>
<td>87 (53)</td>
</tr>
<tr>
<td>ART in a multi-surface cavities in permanent teeth</td>
<td>33 (20)</td>
<td>39 (24)</td>
<td>11 (7)</td>
<td>2 (1)</td>
<td>2 (1)</td>
<td>87 (53)</td>
</tr>
<tr>
<td>ART as an interim treatment in primary teeth</td>
<td>0 (0)</td>
<td>7 (4)</td>
<td>31 (19)</td>
<td>28 (17)</td>
<td>21 (13)</td>
<td>87 (53)</td>
</tr>
<tr>
<td>ART as an interim treatment in permanent teeth</td>
<td>10 (6)</td>
<td>18 (11)</td>
<td>41 (25)</td>
<td>10 (6)</td>
<td>7 (4)</td>
<td>86 (52)</td>
</tr>
<tr>
<td>ART as a definitive treatment in primary teeth</td>
<td>20 (12)</td>
<td>25 (15)</td>
<td>21 (13)</td>
<td>18 (11)</td>
<td>3 (2)</td>
<td>87 (53)</td>
</tr>
<tr>
<td>ART as a definitive treatment in permanent teeth</td>
<td>44 (27)</td>
<td>31 (19)</td>
<td>10 (6)</td>
<td>2 (1)</td>
<td>0 (0)</td>
<td>87 (53)</td>
</tr>
</tbody>
</table>

Table 8 Results of The frequency of Use of Different Types of ART in Pediatric Dentistry Residency Programs
<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Spearman Rank correlation coefficient</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programs that use Nitrous oxide as a behavioral management technique for children older than three years more often</td>
<td>( \rho = .332 )</td>
<td>.01</td>
</tr>
<tr>
<td>Programs that use GA as a behavioral management technique for children three years or younger more often</td>
<td>( \rho = .482 )</td>
<td>.000</td>
</tr>
<tr>
<td>Programs that use GA as a behavioral management technique for children older than three years more often</td>
<td>( \rho = .407 )</td>
<td>.001</td>
</tr>
<tr>
<td>Programs that place amalgam in primary teeth more often</td>
<td>( \rho = -.288 )</td>
<td>.026</td>
</tr>
<tr>
<td>Programs that use MID techniques more often</td>
<td>( \rho = .421 )</td>
<td>.001</td>
</tr>
<tr>
<td>Programs that had their residents spent most of their time in hospital affiliated clinics</td>
<td>( \rho = .263 )</td>
<td>.044</td>
</tr>
<tr>
<td>Programs with directors who had more positive attitude towards ART</td>
<td>( \rho = .456 )</td>
<td>.000</td>
</tr>
</tbody>
</table>

Table 9 Results of Bivariate analysis Using Spearman Rank Correlation Test of the Variable Clinical Training on ART Provided to Residents in Pediatric Dentistry Residency Programs and Selected Independent variables
<table>
<thead>
<tr>
<th>Predictor variable</th>
<th>Beta Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programs with directors who had more positive attitude towards ART</td>
<td>0.346</td>
<td>0.001</td>
</tr>
<tr>
<td>Programs that use MID techniques more often</td>
<td>0.283</td>
<td>0.009</td>
</tr>
<tr>
<td>Programs that use GA as a behavioral management technique for children three years or younger more often</td>
<td>0.285</td>
<td>0.006</td>
</tr>
<tr>
<td>Programs that place amalgam in primary teeth more often</td>
<td>-0.229</td>
<td>0.032</td>
</tr>
</tbody>
</table>

R square = 0.50; F = 4.83, p < 0.03 (Using the stepwise method and confirmed by backward and forward regression)

Table 10 Results of Multiple Linear Regression of the Variable Clinical Training on ART Provided to Residents in Pediatric Dentistry Residency Programs
CHAPTER 5: DOES ATRAUMATIC RESTORATIVE TREATMENT (ART) HAVE A PLACE IN THE US DENTAL SCHOOLS’ CURRICULA? A SURVEY OF PRE-DOCTORAL PEDIATRIC DENTISTRY PROGRAMS

Abstract

Dental Federation (FDI) and World Health Organization (WHO) promoted the use of ART in modern clinical settings worldwide. In the US, the practice of ART is not believed to be widely used. This may be a result of little attention given to ART training in pre-doctoral pediatric dentistry curricula among US dental schools. This study investigated the extent of clinical and didactic instruction on ART provided in US dental schools by surveying the pre-doctoral pediatric dentistry programs in 2010. Of the 57 directors who were asked to complete the survey, 44 complied for a response rate of 77%. Of the 44 programs that are represented in the survey, 66% provided clinical training on ART, though only 14% provide this training often or very often. The types of ART training provided often or very often included interim treatment (18%) and single-surface cavities (14%) in primary teeth. However, ART was rarely taught as definitive treatment in permanent teeth (2%). Attitude was a major predictor for clinical training provided and using professional guidelines in treatment decisions was associated with positive attitude towards ART. Pre-doctoral pediatric dentistry programs used ART mainly in primary, anterior, single surface cavities and as interim treatment.

Introduction

Atraumatic Restorative Treatment (ART) was officially adopted by the World Health Organization in the 1990s. 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. Currently, it has many applications in developed countries, especially for very young children who are being introduced to oral care, patients who experience extreme fear or anxiety about dental procedures, mentally and/or physically challenged patients, home-bound elderly and nursing home resident patients, and patients at high-risk for caries who can benefit from ART as an intermediate treatment to stabilize conditions. In addition, because of its shorter clinical sessions and reduced cost of treatment the ART approach, could be of a particular benefit to underserved children who have high treatment demands, difficult access to dental care and limited financial resources.

According to a systematic review performed by Frencken et al., 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 shown that when using high viscosity GI cements, ART has better clinical results than conventional amalgam restorations. A recent meta-analysis showed that survival of ART restorations was 93% over 2 years in single surface restorations in primary teeth and 80% over 5 years in single surface restorations in permanent teeth. These results qualified ART as an important and effective evidence-based treatment to meet the American Dental Association specification for quality restorations to manage single-surface caries lesions.

The American Academy of Pediatric Dentistry (AAPD) recommends the use of an interim version of ART, the Interim Therapeutic Restorations (ITR) which is identical to ART in technique, scooping out dental caries using hand instruments and placing GI to restore the resultant cavity, but is different in its therapeutic goals. ITR is recommended by 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”. At a public health level, the Indian Health Service, in its most recent initiative to prevent Early
Childhood Caries (ECC), promoted the use of ITR and ART to reduce the need for children having to go to the operating room to receive dental treatment. While recent global and national recommendations were in favor of ART, the use of this procedure is not well established in the US. For example, in a recent study that compared the use of MID techniques between civilian and federal service dentists, the largest percentage of respondents selected “some” for their knowledge of both ART and MID (36.6%), with 13% of respondents who selected “none” for the ART technique. Similarly, in a 2003 national survey among general dental practitioners, 44% of dentists used ART as a restorative procedure to treat children “often” or “very often”. However, 38% of the same sample knew nothing about ART and 40% thought that further training on ART was “very desirable”. 

As noted above and given the strong evidence of the impact of dental education and training on future dentists’ attitude and behavior, the under use 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 curriculum devoted to teaching ART in the US or to the types of clinical experiences dental students have with ART. Therefore, the purpose of this study was to survey pre-doctoral pediatric dental program directors about the 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 on the current role of dental schools in introducing ART into the dental care system and the future possibilities in supporting this procedure as a valid treatment option especially for those whom traditional care is inaccessible or impractical.

Methods

The web-based survey was developed in the fall of 2009 and spring of 2010. It was pretested for content validity, using cognitive analysis (consulting and pre-testing 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 at the University of Iowa, none of whom were 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 pre-testers and the study statistician, the survey was modified for improved clarity and validity. The study was approved by The University of Iowa Institutional Review Board (IRB).

A list of contacts of pediatric dentistry department chairs in US dental schools was obtained from the American Academy of Pediatric Dentistry (AAPD) and was verified by the American Dental Association (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 57 U.S. dental schools. The department chair/division head was asked to forward the survey to the faculty member with primary responsibility for the pre-doctoral program. After a week, an email including a cover letter which 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 non-responders two and four weeks after the first email.

Pre-doctoral program directors were questioned about the characteristics of their programs and the patient population they serv. Besides the demographic characteristics of the program, the survey included questions about the use of behavior management techniques in the program, and the use of different Minimal Invasive Techniques (MID). In addition, the directors answered questions about themselves and their attitudes towards ART.

Directors 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”, and were asked to consider this definition in their
responses. Program directors were asked to report the current level of clinical experience their students receive on ART by answering the question “How often do the dental students use ART as a caries management technique for their patients?“. Responses were measured on a 5 point frequency scale (Never=1 to very often=5). The didactic instruction on ART was measured by the question “Does your program’s didactic instructions teach that preparing cavities using only hand instruments can be a proper technique in certain situations?” and the response was dichotomized as Yes or No.

In order to get a more parsimonious design 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 14 MID procedures that were agreed on during the cognitive analysis phase of the questionnaire development. The scale was the sum of responses of the 14 questions each measured on a five-point frequency scale (never =1, rarely, 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 the respondent who scored “most often” all the time would have a total score of 70 (Table 1).

The second scale or composite variable was about program directors’ attitude 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 sub-question, 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 ±5 (Table 2).
The key independent variables included in the analyses were program director’s age, gender, number of years since graduation, frequency of the use of different behavior management techniques used with children (non-pharmacological, protective stabilization, nitrous oxide, sedation, general anesthesia), frequency of the use of amalgam in the program (primary teeth and permanent teeth), the use of MID techniques in the program (composite variable), and program director’s attitude towards ART (composite variable). Figure 1 shows the conceptual framework of the variables in this study.

Program directors’ responses through the online survey software were exported directly to an Excel spreadsheet accessible to the principal investigator under a protective password. Subjects’ names and personal information (e.g. address, emails…) were kept confidential and were matched to respondents by unique identifiers. These identifiers and associated data were stored and managed on a password secured server to prevent entry by unapproved individuals. The identifiers were used to assess the need for a second contact or future follow up. These identifiers were deleted completely once analysis had been finalized. The data were exported into SPSS data files and the PASW Statistics 18 was used to carry out the analysis.

Statistical analysis

Statistical analyses included descriptive statistics, bivariate analyses and multivariable modeling. Descriptive summary statistics included percentages, means, medians, and standard deviations, with respect to both outcome and potential predictor variables. Associations among potential predictor variables were also explored to exclude any possible interrelationships between predictor variables.

The bivariate analyses were conducted to consider associations between the outcome (dependent) variables and each potential predictor (independent) variable. The three main outcome (attitude towards ART, didactic instruction, and clinical training) variables were measured at ratio, nominal, and ordinal scales, respectively. Predictor
variables were mainly measured at ordinal and ratio scale and some were nominal. Standard $\chi^2$ tests of independence, or Fisher exact tests if needed, were used to evaluate possible relationships among pairs of nominal categorical variables. Spearman’s rank test was used to assess associations between a ratio response and ordinal response, between two ordinal responses or between two ratio responses; for example, between age and a composite score (attitude scale). Mann-Whitney tests and Kruskal Wallis tests were used to assess associations between nominal predictor variables and ordinal or ratio responses.

Variables that demonstrated statistically significant differences in the bivariate analysis ($p \leq 0.05$), had response distribution around 50% and did not correlate with other predictor variables ($\rho > 0.5$) were used to develop the most parsimonious multivariable models. 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. Additionally, possible statistical interactions between the predictor variables were examined. 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 a 0.05 level of statistical significance.

**Results**

Surveys were returned from 44 of the 57 dental schools, for a response rate of 77%. Respondent and non-respondent 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 the school, year established, off-site rotations, presence of advanced standing option for foreign trained dentists, association with other degrees (MPH, PhD, etc…) and enrollment according to race, gender and number. No response bias was detected based on these comparisons. The majority of pre-doctoral programs (66%) reported that they provided clinical instruction on ART to their pre-doctoral students; however, only 14% used this technique “very often” or “often” as
a caries management technique. Table 3 shows the types of ART used by dental students in the US pre-doctoral pediatric dentistry program. 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 %) and in anterior teeth (49 %). Amalgam was “never” used in posterior teeth with ART restorations by 100% of respondents and composite-based materials were used in posterior teeth by 3% of the dental schools.

Among the 44 % who answered “No” to the question “Does your program provide clinical instruction on ART”, 16 % cited “students should learn ideal restorations first” as a reason for not including ART in their training programs. Other reasons cited were “No space in the curriculum” (11.4%), “Insufficient scientific evidence that supports the use of ART” (7%) and “ART is a sub optimum treatment” (5%).

Bivariate analysis for the dependent variable “level of clinical training on ART” is shown in table 4. In multiple linear regressions, 3 predictor variables, the attitude toward ART composite variable, the use of non-pharmacological behavior management techniques with children and parental preference as an important factor in selecting restorative treatment remained significant in the final model (Table 5). Those variables explained 40 % of the variation in the level of clinical training provided in those programs.

The didactic instruction on ART in pre-doctoral pediatric dentistry curriculum was assessed by two sub questions: “Does your program provide any didactic instruction on ART in your curriculum?” and “Does your program's didactic instruction teach that preparing cavities using only hand excavators can be a proper technique in certain situations?” the latter was used as the outcome variable for bivariate and modeling analysis. The majority of respondents (89%) selected “yes” for the first question and 77% selected “yes” for the second question. Most of the didactic instruction was in “lecture”
format (86%), “electronic or paper handouts” (63%), “assigned readings” (54%), “case-based learning” (51%), “small group discussion” (42%), and “video presentation” (7%).

Table 6 shows the bivariate analysis results for the outcome variable “Does your program’s didactic instruction teach that preparing cavities using only hand excavators can be a proper technique in certain situations”. 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” and 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”, which both appeared significant in the bivariate analysis. In addition, although it was not significant in bivariate analysis, the composite variable “Attitude towards ART” was added to the final model to test the hypothesized relationship between attitude and behavior (the didactic instruction provided).

The full model containing all predictors was statistically significant $X^2 = 13$, p<.004, 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% (Cox and Snell R square) and 47 % (Negelkerke R squared) of the variance in didactic instruction on ART, and correctly classified 85 % of cases. As shown in table 6, 2 variables made a unique statistically significant contribution to the model, “Attitude of program directors towards ART” with odds ratio (OR) of 1.3 (95% CI 1.004-1.6) and “dental schools that had a majority of their patient population older than 13 years” (OR= 0.9, 95% CI 0.87-0.995). 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.
Program directors’ attitude towards ART was measured by summing the scores of the five-point agreement Likert scales (5 = strongly agree to 1 = strongly disagree) for each of 10 statements about attitudes towards ART (table 2). For this sample of 44 program directors, the mean score was 39±5 with a range from 27 to 49, where higher values indicated more positive attitudes toward ART.

Bivariate analysis showed that directors who considered professional guidelines and child’s age and behavior as very important factors when discussing different 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. (Table 7)

In the final regression model of the composite variable “Attitude towards ART”, two variables stayed significant and explained 32.4% ($R^2 = 0.32$, $F = 4.6$, P value = .037) of the variation of program directors’ attitudes towards ART. (Table 7) These variables were the disagreement with the statement, “Definitive restorations should be the treatment of choice regardless of other factors” and “Professional guidelines and standard of care as an important factor in selecting restorative treatment”.

Selected program directors’ characteristics are presented in table 8. In general, 70% of respondents were male. Seventy percent had graduated from a US dental training program and 25% completed their training in hospital-based programs. Seventy-three of program directors who responded to this survey were board certified and 39% had other post DMD/DDS training or degrees. When discussing restorative treatment options with their residents, all program directors cited children’s caries risk as “very important” or “important”, 81% cited parental preference as “very important” or “important” and 27% cited patient insurance status or source of payment as “very important” or important. Approximately 95% of program directors reported that continuing education was “very influential” or “influential” on their knowledge regarding different restorative options, and 83% cited post-doctoral training as a “very influential” or “influential” source.
Students in 86% of the respondent pre-doctoral pediatric dentistry programs preformed a caries risk assessment with each new patient. Additionally, dental students in 33 programs provided preventive care such as diet counseling and fluoride application to children 3 years or younger and students in 16 dental schools provided restorative care to children 3 years old or younger. Pre-doctoral program characteristics are shown in table 9.

Patient population served by the respondent pre-doctoral pediatric dentistry programs was mainly financed by Medicaid and other public insurance (64% ±26) and 40% of the respondent dental schools treated children with special health care needs. Characteristics of patient population served by the respondent pre-doctoral pediatric dentistry program are summarized in table 10.

Discussion

The first step to introduce any new procedure to a health system is the training of professionals, allowing them to understand the philosophy behind the new technique as well as the actual technique itself. Studies in the literature that have investigated the barriers to using ART found that professionals’ lack of training on ART was a major obstacle in using it.\textsuperscript{23,24} Since ART is based on good evidence and has many application in modern clinical settings\textsuperscript{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 their treatment plans with parents or other decision-makers. In a study that collected information about education in Cariology for dental students in Europe, 83% of schools (102 dental schools) supported the inclusion of ART in the curriculum.\textsuperscript{182} However, no such information exists in the U.S., as to the best of our knowledge; the present study is the first to investigate the didactic and clinical instruction provided on ART in pre-doctoral pediatric dentistry programs in US dental schools.

This study used an online survey sent to pediatric dentistry program directors in 57 dental schools identified by the AAPD and verified by the American Dental
Association (ADA) in 2010. The response rate of 77% was considered to be good, suggesting that the findings may be generalized to all dental schools. Moreover, no response bias was found between respondent dental schools and non-respondents dental schools when they were compared on dental schools characteristics obtained from American Dental Education Association (ADEA) web site, \(^{183}\) which further suggests that our sample was representative of all US dental schools. However, we cannot claim the representativeness of the program directors themselves because we did not directly compare the characteristics of the program directors.

The results revealed that 66% of dental schools provided clinical instruction on ART in their pre-doctoral pediatric dentistry programs; however, only 14% used this procedure “often” or “very often” and 23% used it “rarely” as a caries management technique. In comparison, another study that was conducted in 2003 showed that 36% of a national sample of dental practitioners in the US received hands-on training on ART and 38% received none. \(^{179}\) In this same study, 44% of general dental practitioners cited the use of ART in their current practices “often” or “very often” and 28% used it “rarely” or “never”. \(^{148}\) In a study that compared dental caries management decisions for primary teeth by general practitioners in England and Japan, 30% of dentists in Japan used ART for a single distal cavity in a vital tooth without history of pain and 62% used traditional restorative treatment. Using the same clinical scenario, 57% of English dentists used ART and 35% used traditional restorative treatment. \(^{184}\)

Our study results showed that the main use of ART in pre-doctoral pediatric dentistry clinics was in primary teeth and as an interim treatment. This agrees with the use of ART in pediatric dentistry residency programs \(^{185}\) and the new revision of AAPD policy on 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”, \(^{160}\) 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”. Thus, AAPD endorsed only the interim version of ART in modern dental practice.

The literature shows that the highest survival rate for ART is for single surface when resin modified GI (RMGI) is used. This kind of restoration meets the ADA specification for quality restorations. Our study showed that 57% of the pre-doctoral pediatric dentistry training used RMGI “very often” or “often” compared to 16% which used conventional GI. And as expected, 21% of the programs used ART in single surface in primary teeth “very often” or “often” while only 14% used it multiple surfaces restorations “often” or “very often”.

When the association between predictor variables and the outcome variable “level of clinical instruction on ART” was assessed, 3 variables remained significant in the final regression model and explained 40% of the variation in the level of training provided. The variable “use of non-pharmacological behavior management techniques with children” alone and with controlling for other variables, explained 36% of the variation in our outcome variable. Our survey results showed that 94% of pre-doctoral pediatric dentistry programs used non-pharmacological techniques more often to manage children behaviors. Thus, in settings that depend mainly on non-pharmacological behavior management techniques to gain children’s cooperation, ART techniques would be valuable because of its atraumatic, patient-friendly nature.

The second variable that explained 35% 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 children treatment planning, and as demonstrated in the literature, acceptance of ART among patients was high when the procedure and its therapeutic goals were explained properly to them.

The third variable was the attitude of program directors toward ART scale which explained 27% 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 as cited by other literature.  

Program directors who did not provide any training on ART in their curriculum justified that for different reasons. Reasons that were selected more frequently such as “dental students should learn ideal restorations first”, “insufficient scientific evidence that support the use of ART”, and “It is sub optimum treatment”, reflect a very negative attitude towards ART and lack of knowledge of the good evidence behind ART.

In contrast, a few program directors that did not provide any training on ART raised logistical challenges that limit the use of ART in pre-doctoral pediatric dentistry clinics. One important challenge was that at some institutions the decisions regarding product ordering and utilization is not controlled by the departments. Thus, the access to materials needed for ART, such as resin modified GI, may not be available for undergraduate students.

Eighty–seven percent of the programs responded with “Yes” to providing didactic instruction on ART for their students and 77% said “Yes” when they were asked if they provided didactic instruction “that preparing cavities using only hand excavators can be a proper technique in certain situations”. In spite of the high response rate, the small sample number and skewed response distribution in this study limited the analysis of the dichotomized outcome variable “didactic instruction”. The whole model predicted 29% to 47% of the odds to provide didactic instruction on ART. Two predictors made a significant contribution to the model, 1) attitudes towards ART, which was also a major predictor for the clinical training provided, and 2) dental schools that had majority of their patient population older than 13 years provided less didactic instruction on ART. This age group is old enough to cooperate favorably with traditional dental care which makes the need of a patient-friendly procedure like ART less crucial.

The program directors’ attitudes toward ART was measured using a scale and its distribution was skewed towards a more positive attitude, where only 1 program director
scored less than 30 on the scale (the scale ranges from 10 to 50) and 17 program directors scored between 40 and 50 on the same scale. However, our results showed that 23 program directors out of 44 scored between 30 and 40 on the attitude scale, which indicates that most of the program directors are more neutral towards ART. This appears to be in line with the results of our previous work, where US pediatric dentistry residency program directors showed very similar attitude towards ART. In like manner, other US national studies in 2006 and 2009 showed relatively more positive attitudes towards MID in general and towards ART in particular among civilian, federal and public health dentists.

Two predictor variables in the final model explained 32% of the variation in the attitude of program directors towards ART. A strong predictor for program directors’ attitude toward ART was the belief that professional guidelines are very important factors in restorative treatment modalities’ selection. Professional guidelines were usually rated in different surveys of pediatric and general dentists as an important factor in selecting treatment modalities. This also agrees with our previous work that shows professional guidelines as an important predictor of the attitude of pediatric dentistry residency program directors. Although the AAPD guidelines gave ART another name and endorse it only as interim restoration, it encourages its use with very young, uncooperative and high caries risk children.

Additionally, program directors 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 was in the US toward definitive restorations as the treatment of choice, currently many dental practitioners have started to believe in less invasive procedures, 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 pre-doctoral training on ART, it did have some limitations. One such limitation was the small size of the population. Although we had a high response rate of 77%, the number of dental schools accredited by the ADA in 2010 (57 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 particular list available at the AAPD or ADEA for pre-doctoral pediatric dentistry program directors and sometimes such a 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 pediatric dentistry programs; however, the focus of this paper in particular is child restorative treatment options, so we think we can consider our results as valid to answer this question.

This survey also had limitations inherent to other surveys, such as the limits on the nature and quality of the information imposed by survey design. However, using online survey for this particular population who has an easy access to the web was an important factor in the high response rate.

Studies have demonstrated that the ART approach produces quality restorations in single-surfaces in both primary and permanent teeth using high viscosity or resin modified GI. ART with its low cost and atraumatic nature can be a means to alleviate the problem of access to dental care among underserved population. 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 the correct use of ART. Equally important, the right instruments and the correct materials should be sufficiently available in pre-doctoral pediatric dentistry clinics to support programs to use ART.
Conclusions

Sixty-six percent of pre-doctoral pediatric dentistry programs in the US provided clinical training on ART; however only 14 % of those programs used ART “Very Often/Often” as a caries management technique for their pediatric patients. Pre-doctoral pediatric dentistry programs used ART mainly in primary, anterior, single surface cavities and as interim treatment.

The importance of professional guidelines as a factor in selecting treatment options, explained 41% of the variation in the attitude of program directors toward ART and 27% of the variation in the level of clinical training on ART provided to pre-doctoral students. Consequently, professional organizations should endorse dental procedures such as ART that are based in good evidence so as to better serve the needs of certain populations and improve their access to dental care.
Figure 2 Conceptual Model of Study II
<table>
<thead>
<tr>
<th>MID procedures</th>
<th>Never k%</th>
<th>Rarely %</th>
<th>Sometimes %</th>
<th>Often %</th>
<th>Very often %</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placing sealants in incipient carious fissures in permanent teeth</td>
<td>9(4)</td>
<td>11(5)</td>
<td>23(10)</td>
<td>27(12)</td>
<td>30(13)</td>
<td>100(44)</td>
</tr>
<tr>
<td>Placing sealants in incipient carious fissures in primary teeth</td>
<td>23(10)</td>
<td>23(10)</td>
<td>30(13)</td>
<td>18(8)</td>
<td>7(3)</td>
<td>100(44)</td>
</tr>
<tr>
<td>Placing sealants in minimally cavitated lesions in permanent teeth</td>
<td>41(18)</td>
<td>21(9)</td>
<td>25(11)</td>
<td>9(4)</td>
<td>5(2)</td>
<td>100(44)</td>
</tr>
<tr>
<td>Using tunnel approach in primary or permanent teeth</td>
<td>55(24)</td>
<td>30(13)</td>
<td>16(7)</td>
<td>-</td>
<td>-</td>
<td>100(44)</td>
</tr>
<tr>
<td>Placing glass-ionomer restorations in anterior primary teeth</td>
<td>5(2)</td>
<td>30(13)</td>
<td>50(22)</td>
<td>14(6)</td>
<td>2(1)</td>
<td>100(44)</td>
</tr>
<tr>
<td>Placing glass-ionomer restorations in posterior primary teeth</td>
<td>2(1)</td>
<td>30(13)</td>
<td>50(22)</td>
<td>14(6)</td>
<td>2(1)</td>
<td>100(44)</td>
</tr>
<tr>
<td>Placing glass-ionomer restorations in anterior permanent teeth</td>
<td>11(5)</td>
<td>56(24)</td>
<td>32(14)</td>
<td>2(1)</td>
<td>-</td>
<td>100(44)</td>
</tr>
<tr>
<td>Placing glass-ionomer restorations in posterior permanent teeth</td>
<td>14(6)</td>
<td>48(21)</td>
<td>30(13)</td>
<td>5(2)</td>
<td>2(1)</td>
<td>99(43)</td>
</tr>
<tr>
<td>Placing composite-based restorations in anterior primary teeth</td>
<td>-</td>
<td>16(7)</td>
<td>9(21)</td>
<td>12(27)</td>
<td>16(36)</td>
<td>100(44)</td>
</tr>
<tr>
<td>Placing composite-based restorations in posterior primary teeth</td>
<td>2(1)</td>
<td>5(2)</td>
<td>28(12)</td>
<td>44(19)</td>
<td>21(6)</td>
<td>98(43)</td>
</tr>
<tr>
<td>Placing composite-based restorations in posterior permanent teeth</td>
<td>-</td>
<td>2(1)</td>
<td>30(13)</td>
<td>43(19)</td>
<td>11(25)</td>
<td>100(44)</td>
</tr>
<tr>
<td>Placing preventive resin restorations in primary teeth</td>
<td>7(3)</td>
<td>9(4)</td>
<td>48(21)</td>
<td>16(7)</td>
<td>21(6)</td>
<td>100(44)</td>
</tr>
<tr>
<td>Placing preventive resin restorations in permanent teeth</td>
<td>-</td>
<td>9(4)</td>
<td>23(10)</td>
<td>34(15)</td>
<td>34(15)</td>
<td>100(44)</td>
</tr>
<tr>
<td>Using ART as a caries management technique</td>
<td>34(15)</td>
<td>23(10)</td>
<td>27(12)</td>
<td>11(5)</td>
<td>2(1)</td>
<td>98(43)</td>
</tr>
</tbody>
</table>

Table 11  Distribution of Responses to Questions Regarding Frequency of Use of Selected MID Procedures in Pre-doctoral Pediatric Dentistry training
<table>
<thead>
<tr>
<th>Attitude statements</th>
<th>Strongly agree % (n)</th>
<th>Somewhat agree % (n)</th>
<th>Neither agree nor disagree % (n)</th>
<th>Somewhat disagree % (n)</th>
<th>Strongly disagree % (n)</th>
<th>Total % (n)</th>
</tr>
</thead>
</table>

Table 12 Distribution of Responses to Questions Regarding Agreement or Disagreement to 9 Statements that described Attitude of Pediatric Dentistry Program directors towards ART
<table>
<thead>
<tr>
<th>Types of ART used in the pediatric dentistry residency programs</th>
<th>Never % (n)</th>
<th>Rarely % (n)</th>
<th>Sometimes % (n)</th>
<th>Often % (n)</th>
<th>Very often % (n)</th>
<th>Total % (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ART in anterior primary teeth</td>
<td>-</td>
<td>18(8)</td>
<td>34(15)</td>
<td>9(4)</td>
<td>5(2)</td>
<td>65(29)</td>
</tr>
<tr>
<td>ART in anterior permanent teeth</td>
<td>18(8)</td>
<td>32(14)</td>
<td>14(6)</td>
<td>2(1)</td>
<td>-</td>
<td>65(29)</td>
</tr>
<tr>
<td>ART in posterior primary teeth</td>
<td>-</td>
<td>30(13)</td>
<td>25(11)</td>
<td>2(1)</td>
<td>9(4)</td>
<td>66(29)</td>
</tr>
<tr>
<td>ART in posterior permanent teeth</td>
<td>9(4)</td>
<td>39(17)</td>
<td>9(4)</td>
<td>7(3)</td>
<td>2(1)</td>
<td>66(29)</td>
</tr>
<tr>
<td>ART in single-surface cavities in primary teeth</td>
<td>-</td>
<td>25(11)</td>
<td>27(12)</td>
<td>7(3)</td>
<td>7(3)</td>
<td>66(29)</td>
</tr>
<tr>
<td>ART in a single-surface cavities in permanent teeth</td>
<td>9(4)</td>
<td>39(17)</td>
<td>9(4)</td>
<td>5(2)</td>
<td>2(11)</td>
<td>64(28)</td>
</tr>
<tr>
<td>ART in multi-surface cavities in primary teeth</td>
<td>9(4)</td>
<td>27(12)</td>
<td>21(9)</td>
<td>7(3)</td>
<td>2(1)</td>
<td>66(29)</td>
</tr>
<tr>
<td>ART in a multi-surface cavities in permanent teeth</td>
<td>25(11)</td>
<td>25(11)</td>
<td>7(3)</td>
<td>7(3)</td>
<td>2(1)</td>
<td>66(29)</td>
</tr>
<tr>
<td>ART as an interim treatment in primary teeth</td>
<td>-</td>
<td>5(11)</td>
<td>36(16)</td>
<td>11(5)</td>
<td>7(3)</td>
<td>66(28)</td>
</tr>
<tr>
<td>ART as an interim treatment in permanent teeth</td>
<td>5(2)</td>
<td>30(13)</td>
<td>23(10)</td>
<td>5(2)</td>
<td>2(1)</td>
<td>64(28)</td>
</tr>
<tr>
<td>ART as a definitive treatment in primary teeth</td>
<td>16(7)</td>
<td>27(12)</td>
<td>16(7)</td>
<td>5(2)</td>
<td>2(1)</td>
<td>66(29)</td>
</tr>
<tr>
<td>ART as a definitive treatment in permanent teeth</td>
<td>39(17)</td>
<td>21(9)</td>
<td>2(1)</td>
<td>2(1)</td>
<td>-</td>
<td>64(28)</td>
</tr>
</tbody>
</table>

Table 13 Results of The frequency of Use of Different Types of ART in Pre-doctoral Pediatric Dentistry clinical training
<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Statistical test</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of graduation of the program chair or coordinator</td>
<td>Spearman’s Rho=0.33</td>
<td>0.031</td>
</tr>
<tr>
<td>Board certification</td>
<td>Mann-Whitney U test=94</td>
<td>0.017</td>
</tr>
<tr>
<td>The use of non-pharmacological behavior management technique for children younger than 3 years</td>
<td>Rho=0.46</td>
<td>0.002</td>
</tr>
<tr>
<td>Program directors who consider “Parental preference” is an important factor when discussing treatment decisions with students</td>
<td>Rho= 0.436</td>
<td>0.003</td>
</tr>
<tr>
<td>Program directors who consider “Professional guidelines and standard of care” is an important factor when discussing treatment decisions with students</td>
<td>Rho= 0.396</td>
<td>0.009</td>
</tr>
<tr>
<td>Program directors who disagree with that “Definitive restorations should be the treatment of choice regardless of other factors”</td>
<td>Rho=0.328</td>
<td>0.032</td>
</tr>
<tr>
<td>Attitude of program director towards ART</td>
<td>Rho=0.421</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Table 14 Results of Bivariate Analysis of the Variable Clinical Training on ART Provided in Pre-doctoral Pediatric Dentistry Clinical Training and Selected Independent variables
<table>
<thead>
<tr>
<th>Predictor variable</th>
<th>Beta Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parental preference as an important factor in selecting restorative treatment</td>
<td>0.35</td>
<td>0.009</td>
</tr>
<tr>
<td>The use of non-pharmacological behavior management techniques with children</td>
<td>0.36</td>
<td>0.007</td>
</tr>
<tr>
<td>Attitude of department chair towards ART</td>
<td>0.27</td>
<td>0.046</td>
</tr>
</tbody>
</table>

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

Table 15 Results of Multiple Linear Regression of the Variable Clinical Training on ART Provided in Pre-doctoral Pediatric Dentistry clinical training
Table 16 Results of Bivariate analysis of the Variable Didactic Instruction on ART Provided to Dental students in Pediatric Dentistry curriculum and Selected Independent variables and the Results of the Logistic Regression of the Variable Didactic Instruction on ART

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Mann-Whitney U-test</th>
<th>B coefficient</th>
<th>P-value</th>
<th>Odds ratio</th>
<th>95% CI for odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of children older than 13 years treated by the dental students</td>
<td>80, p&lt;.04</td>
<td>-0.075</td>
<td>0.037</td>
<td>0.927</td>
<td>0.864-0.995</td>
</tr>
<tr>
<td>Agreement with the statement &quot;A formal caries risk assessment should be carried out periodically and thoroughly for all children in the pediatric dental office&quot;</td>
<td>105, p&lt;.02</td>
<td>1.627</td>
<td>0.08</td>
<td>5.1</td>
<td>0.62-31.6</td>
</tr>
<tr>
<td>Attitude of program directors towards ART</td>
<td>128, p&lt;0.3</td>
<td>0.232</td>
<td>0.046</td>
<td>1.27</td>
<td>1.004-1.59</td>
</tr>
</tbody>
</table>

For this model, Cox and Snell R² = 29%, Nagelkerke R² = 47%
Table 17  Results of Bivariate analysis Using Spearman Rank Correlation test of the Attitude of Program Directors towards ART Composite Variable and Selected Predictor Variables and the Results of the Multiple Linear Regression of the Attitude of Program directors towards ART

<table>
<thead>
<tr>
<th>Predictor variable</th>
<th>Spearman Rho ranking test</th>
<th>Beta Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional guidelines and standard of care as an important factor in selecting restorative treatment</td>
<td>0.48, p &lt; 0.001</td>
<td>0.417</td>
<td>0.003</td>
</tr>
<tr>
<td>Disagreement with the statement “Definitive restorations should be the treatment of choice regardless of other factors”</td>
<td>0.41, P &lt; 0.005</td>
<td>0.288</td>
<td>0.037</td>
</tr>
</tbody>
</table>

R square = 0.32; F = 5, p < 0.037 (Using the stepwise method and confirming the results with forward and backward regression)
<table>
<thead>
<tr>
<th>Program director characteristics</th>
<th>Mean</th>
<th>Median</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>54</td>
<td>55</td>
<td>11</td>
<td>32</td>
<td>82</td>
</tr>
<tr>
<td>Number of years spent in the following settings before becoming a program director:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private practice</td>
<td>6</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Academics (Full time faculty)</td>
<td>10</td>
<td>6</td>
<td>11</td>
<td>0</td>
<td>52</td>
</tr>
<tr>
<td>Public Health Service</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Military dental corps</td>
<td>0.8</td>
<td>-</td>
<td>4</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Percentage of time per week spent in each of the following in the past 12 months:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research</td>
<td>10</td>
<td>10</td>
<td>11</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>Administration</td>
<td>28</td>
<td>25</td>
<td>18</td>
<td>0</td>
<td>79</td>
</tr>
<tr>
<td>Direct patient care</td>
<td>17</td>
<td>20</td>
<td>15</td>
<td>0</td>
<td>70</td>
</tr>
</tbody>
</table>

Table 18: Respondents Pre-doctoral Pediatric Dentistry Program directors’ Characteristics
<table>
<thead>
<tr>
<th>Pre-doctoral pediatric dentistry program characteristics</th>
<th>Frequency</th>
<th>Valid %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental school main location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban area – Inner city</td>
<td>28</td>
<td>65</td>
</tr>
<tr>
<td>Urban area, but not located in the inner city</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Urban area, suburb</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Small city</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Rural or small town</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Behavioral management techniques used with children in the pediatric dentistry clinic “most often” or “often”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non pharmacological behavior management</td>
<td>40</td>
<td>94%</td>
</tr>
<tr>
<td>Protective stabilization (Medical immobilization, papoose board)</td>
<td>4</td>
<td>9%</td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td>17</td>
<td>39%</td>
</tr>
<tr>
<td>Sedation</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>General Anesthesia</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Percentage of dental students’ time spent in each of the following settings</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>On-site dental school facilities</td>
<td>70%</td>
<td>27%</td>
</tr>
<tr>
<td>Affiliated hospital-based dental clinics</td>
<td>5%</td>
<td>9%</td>
</tr>
<tr>
<td>Off-site, satellite or affiliated dental clinics</td>
<td>14%</td>
<td>22%</td>
</tr>
<tr>
<td>Off-site, Public Health clinics</td>
<td>9%</td>
<td>19%</td>
</tr>
<tr>
<td>Off-site, migrant worker camps</td>
<td>0.05%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Off-site, international programs</td>
<td>0.4%</td>
<td>2%</td>
</tr>
<tr>
<td>Patients population’s characteristics</td>
<td>Mean</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>-------------------------------------------------------------------</td>
<td>------</td>
<td>----------------</td>
</tr>
<tr>
<td>Covered by Medicaid and other public insurance</td>
<td>64%</td>
<td>25%</td>
</tr>
<tr>
<td>Covered by private insurance</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>Have no insurance (out of pocket)</td>
<td>20%</td>
<td>22%</td>
</tr>
<tr>
<td>Proportion of high risk children treated in pediatric dentistry residency programs</td>
<td>63%</td>
<td>20%</td>
</tr>
<tr>
<td>Proportion of low risk children treated in pediatric dentistry residency programs</td>
<td>27%</td>
<td>13%</td>
</tr>
<tr>
<td>Proportion of children younger than 3 years treated in pediatric dentistry residency programs</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Proportion of 3-5 years children treated in pediatric dentistry residency programs</td>
<td>20%</td>
<td>16%</td>
</tr>
<tr>
<td>Proportion of 6-12 years children treated in pediatric dentistry residency programs</td>
<td>57%</td>
<td>18%</td>
</tr>
<tr>
<td>Proportion of children 13 and older treated in pediatric dentistry residency programs</td>
<td>20%</td>
<td>16%</td>
</tr>
</tbody>
</table>

Table 209 Characteristics of patient population served by the pre-doctoral pediatric dentistry program
CHAPTER 6: THE WILLINGNESS OF US PEDIATRIC DENTISTS TO USE ATRAUMATIC RESTORATIVE TREATMENT (ART) WITH THEIR PATIENTS: A CONJOINT ANALYSIS

Abstract

The American Academy of Pediatric Dentistry (AAPD) defines Atraumatic Restorative Treatment (ART) as a means of restoring and preventing caries in populations that have little access to traditional dental care or patients for whom traditional cavity preparation are not feasible. However, little is known about the use of (ART) among pediatric dentists in the US. The aim of this study was to determine factors that influence pediatric dentists’ decision to use ART with their pediatric patients. A conjoint survey was sent to a random sample of 2237 members registered as specialists by the American Academy of Pediatric Dentistry. We identified three factors (age of the child, level of cooperation, type of insurance) and varied each across three levels to create a nine cell conjoint design (9 clinical scenarios). We were then able to elicit weights practitioners place on these factors. Factors such as lesion location, depth and extension were fixed in the nine clinical scenarios. Seven-hundred twenty three pediatric dentists completed the survey with a response rate of 32%. Age of the child had the biggest importance in pediatric dentists’ decisions to use ART (46%) compared to level of cooperation (41%) and type of insurance coverage (11%). For the age factor, age of two years had the greatest utility (0.55) compared to age 4 (-0.09) and age 6 (-0.46). For types of insurance coverage, having no insurance (0.124) had the greatest utility compared to having public insurance (-0.119). Conjoint Analysis is a valid procedure to show the weights practitioners place on different factors that may influence their decision to use ART. Although insurance coverage was the least important among other factors, being
without insurance along with being very young and uncooperative child seems to be good reasons to receive ART when participants needed to tradeoff between different levels of different factors using the conjoint design.

**Introduction**

The Atraumatic Restorative Treatment (ART) was developed in the 1980s as an affordable, patient-friendly dental caries management procedure that does not need extensive operator training or special skills and the early applications were in field settings in developing countries where access to conventional dental care was not readily available. ART consists of removing dental caries using only hand instruments combined with restoring a tooth and sealing the adjacent fissures with an adhesive restorative material, mainly GIC. Recent research presents ART as a procedure that conforms to modern minimal invasive dentistry concepts and meets the American Dental Association (ADA) specification for quality restorations to manage single-surface caries lesions. A meta-analysis in 2010 showed that survival of ART restorations was 93% in single surface restorations over 2 years and 62% in multiple surface restorations in primary teeth. In permanent teeth, ART had an 80% survival rate over 5 years in single-surface restorations and 86% over one year in multiple surface restorations. When compared with amalgam, a 2011 systematic review showed that no significant differences exists between the two types of restorations after 12 and 24 months in primary teeth, and ART did better than amalgam for up to 6.3 years in permanent teeth. In addition, new observations have shown that ART has many applications in a modern clinical settings as well as in developed countries, especially for very young children who are being introduced to oral care, patients who experience extreme fear or anxiety about dental procedures, mentally and/or physically challenged patients, home-bound elderly and nursing home resident patients, and patients at high-risk caries who can benefit from ART as an intermediate treatment to stabilize conditions. Equally important, the ART approach, because of its shorter clinical sessions and reduced cost of
treatment, could be of a particular benefit to underserved children who have high treatment demands, those with difficult access to dental care and limited financial resources.

In the US, The American Academy of Pediatric Dentistry (AAPD) considers ART an Interim Therapeutic Restoration (ITR) for caries stabilization in children with multiple cavitated lesions. However, despite the advantages discussed above, the practice of ART is not believed to be widely used. Factors related to the use of ART in the US among pediatric dentists are still unknown.

This study was designed to determine the magnitude and complexity of the factors impacting pediatric dentists’ decision to use Atraumatic Restorative Treatment (ART) to manage a caries lesion in a child patient. In this study, given that ART is more valuable for children with problematic access to dental care, we decided to focus on the behavioral and system factors related to such a decision.

Self-report surveys that ask direct questions about treatment decisions, and use simple ranking techniques, have been the common methodology used to gather information about the factors that influence professionals’ decision to use certain dental restorative procedures over others. This common measure of professionals’ “stated decision”, evaluating one factor at a time, does not assess the “derived decision” or relative importance of each factor. Simple self-report surveys are also susceptible to social desirability, failing to both incorporate any concept of opportunity cost and measure preference strength. To avoid those shortfalls, we used conjoint design to investigate factors affecting pediatric dentists’ decision whether to use ART with their child patients. Conjoint analysis can better model actual decision making because it requires respondents to make trade-offs in a holistic context, as opposed to others surveys which do not impose a resource constraint; for example, respondents can rate all attributes as “extremely important” without having to evaluate trade-offs.
Conjoint analysis, which was developed originally in economic and marketing research, was based on the theory that decision options can be described by sets of attributes or factors, each made up of different levels.\textsuperscript{199, 200} The relative value that professionals attach to different factors can be estimated by constructing a series of hypothetical scenarios made up of these factors at different levels and asking professionals to rate, rank, or make choices within a set of hypothetical options.

Conjoint analysis has been used as a valid predictor of real world decisions in many studies,\textsuperscript{201} and it has been successfully applied in many health care applications as an instrument for establishing preference among clinicians.\textsuperscript{200} This technique has been investigated with encouraging results for its completeness, stability, rationality and ability to avoid social bias.\textsuperscript{202}

A number of examples of conjoint analysis have been utilized in public health and health care research.\textsuperscript{203-208} In spite of this, the use of conjoint analysis is still rare in dental research.\textsuperscript{196-198} One of the applications where conjoint analysis was used in dental research assessed the determinants of dentists’ decisions to initiate a particular restorative treatment, dental implants. This study found disagreement between what dentists say to be important (self-reported task) and the factors they actually use to judge the suitability of implant treatment (hypothetical scenarios based on a conjoint task).\textsuperscript{196} In other words, social desirability which is a big concern in self-reported surveys was minimized when conjoint task was used in the previous example.

One of the most important characteristics of conjoint analysis is that it elicits preferences of a decision over the range of factors and levels that define the hypothetical scenarios used in the conjoint-analysis questions.\textsuperscript{209} Although all factors that influence pediatric dentists’ decision to use ART should be considered, information and statistical efficiency dictate the use of a limited number of factors to produce the most relevant and efficient parsimonious design.\textsuperscript{210} The literature suggests age,\textsuperscript{122,211,214} child’s
cooperation,\textsuperscript{122,211,214} and insurance coverage \textsuperscript{122,211,214} to be three of the most important system and behavioral factors that influence providers’ treatment decision.

The objectives of this study were to investigate the influence of child’s age, level of cooperation and insurance coverage on willingness of pediatric dentists to perform ART restorations using hypothetical patient scenarios and conjoint design. Learning more about what really influences professionals’ decision to use a newly introduced restorative treatment procedures is a useful approach for explaining delays or resistance to the incorporation of new knowledge in clinical practice in general and for ART procedures in particular. In this study, we hypothesized that pediatric dentists’ use ART is higher for younger children, for uncooperative children, and for those without insurance.

\textbf{Method}

This was a cross-sectional exploratory study using a web-based questionnaire with 21 items. The survey was pre-tested for content validity, using cognitive analysis by faculty members from the Department of Preventive and Community Dentistry and Department of Pediatric Dentistry, at the University of Iowa during spring of 2010. Pilot testing for face validity was carried out by six pediatric dentistry senior residents.

After pre-testing and revision, a national random sample of 2237 active members of the American Academy of Pediatric Dentistry (AAPD), all of whom were registered as pediatric specialists, was invited to participate in this survey in May 2011. (Figure 1)

An invitation email, signed by the principal investigator, research chairperson, and two members of the research committee was sent to AAPD members in the first week of May 2011. The invitation email explained the objectives of the study gave a general idea about the nature and number of the questions and included a link to the web survey. The invitation email also included the components required by the University of Iowa Institutional Review Board (IRB) to ensure that respondents understood that research participation was voluntary and all identifiers would be removed after the data analysis was completed. Thus, formal written consent was not required; submitting a
completed questionnaire constituted the subject's consent. The IRB approved all aspects of this study. Reminder emails with the web survey link were sent again after two, four and six weeks from the original first email to those participants who did not submit the completed survey or did not opt out. A thank you email was sent to all participants.

The questionnaire had 3 sections: (I) nine conjoint questions, (II) nine demographic and practice characteristics questions, and (III) three follow-up questions about the direct use of ART. Questions concerning demographic and practice characteristics were modeled on previous AAPD surveys to its members\textsuperscript{215,216} where validity and reliability of the questions had already been tested. In addition, we asked respondents if they consider ART to be definitive or interim treatment and why, as well as from where they learned about ART. ART and ITR were defined in the introduction of the survey.

**Conjoint questions**

Each participant was presented with 9 patient scenarios; each scenario represented a specific scenario of a child patient with dental caries seeking restorative treatment. Column 2 in table 4 gives some examples of the scenarios presented to respondents. The clinical presentation of the dental caries in the nine patient scenarios was fixed, so that all scenarios had the same carious lesion in an upper anterior primary tooth deep into the dentin but with no pulpal involvement evident clinically or radiographically. System and behavioral factors were manipulated in these scenarios to investigate non clinical factors that may influence the selection of ART as a treatment option. A range of potentially important non-clinical patient factors that could influence practitioner’s decision to use certain restorative modalities were identified from the literature and then these factors were refined by consultations with experts from pediatric dentistry, dental public health and health policy.
Factors and levels selection

This expert panel identified three non-clinical factors or patient attributes (age of the child, cooperation level of the child and insurance coverage that the child may have) that may be important in making a pediatric dentist more or less willing to select one restorative modality over another. For each attribute, 3 levels were identified as shown in figure 2.

Literature and expert opinions helped in assigning the appropriate levels for each factor. For the factor “age of the child”, we chose the ages 2, 4 and 6, which coincide with three important stages of lifecycle of primary teeth and three milestones in children psychological and behavioral development For the factor “child cooperation in the clinical setting”, we used Frankl’s classification, in which we assigned “Uncooperative” for Frankl's class 1, “Shows moderate cooperation” for Frankl's class 2 and “Cooperative” for Frankl's classes 3 and 4. Frankl behavioral scale is recommended by the AAPD guidelines to rate children behavior in clinical setting \(^{217}\) and was defined in the introduction of the survey.

The factor insurance coverage indicates whether a child is eligible to have payments made to a dental care provider on their behalf by a third party.\(^ {218}\) The literature and governmental and non-governmental reports have identified three sources of payment that finance children’s dental care services. For example, the Medical Expenditure Panel Survey in 2004 showed that 54% of the community population had private coverage during the year.\(^ {219}\) Thus, in this study, insurance was categorized as private insurance, public insurance or no insurance coverage, with public dental coverage considered to include Medicaid and the State Children’s Health Insurance Program (SCHIP).

Conjoint design

For our study, 723 respondents submitted the on-line survey, and after incomplete participants’ rating data and rating data that showed no variation were excluded, our final sample that was used in the conjoint analysis was 523. However, for descriptive findings
and ART follow-up questions, we used the whole original sample of 723. We considered 300 to be our minimum sample size based on previous studies using conjoint analysis; this number assumes a margin of error of 3% around utility values estimates and a confidence interval of 95%.  

Response bias was checked by comparing the original sample with the whole AAPD pediatric dentistry specialist emailing list and by comparing the demographic data for respondents who were included in the analysis with both the original sample and the whole emailing list using demographic data.

The conjoint method was used in this study to determine pediatric dentists’ drivers to use ART by rating their willingness to use ART in the nine patients’ scenarios. From this, the value dentists attach to different factors when faced with different situations that need their decisions to initiate treatment was calculated. In this study we used a metric measure, in which the measurement scale of the dependent variable, willingness to use ART, was interval. For each patient scenario, pediatric dentists rated the strength to which they were willing to use ART on a 5-point scale, ranging from 5 = “Very likely to use ART” to 1= “Very unlikely to use ART”. The main advantage of the metric method is the increased information content present in the interval measured scales.

Although a large number of attribute levels could have been developed, we decided to confine the number to 3 attributes and 3 levels to limit respondent burden and increase information efficiency. We further refined attribute categories for clarity of content using consultation with our expert panel and comments from the participants in the pilot testing of the conjoint analysis questions.

Because 27 patient scenarios would have been needed to present all possible combinations of the 3 factors, we had concerns about information overload. Thus, to manage the complexity of the task; we reduced the number of patient scenarios to a more acceptable 9 by applying an orthogonal fractional factorial, main effects design that
maintained the statistical efficiency. This design, using principles of independence and balance, provides a subset of all possible combinations of characteristics and allows estimations of the relative weights for each level of the presented factors on the willingness to use ART score. SPSS Conjoint software was used to generate the fractional factorial conjoint design. With this technique, the independent effect of the factor’s level on the willingness score can still be estimated, but the two-way interaction effects between levels cannot be evaluated. However, it is important to note that even though a subset of potential patient scenarios were randomly selected and presented to the participant, the software algorithm (using an orthogonal design) is programmed to extrapolate total utility values for all possible patient scenarios for each study participant. Figure 3 shows the steps in constructing the conjoint design in this survey.

**Data Management**

Data gained through the online survey software were exported directly to an Excel sheet accessible to the principal investigator under a protective password. Subjects’ names and personal information (e.g. address, emails…) were kept confidential and attached to respondents by identifiers. These identifiers and associated data were stored and managed on a password secured server to prevent entry by unapproved individuals. The identifiers were used to assess the need for a second contact or future follow up and were deleted completely once analysis had been finalized. The data were exported into SPSS data files and the PASW SPSS Statistics 18 \(^{154}\) was used to carry out the analysis.

**Data analysis**

The conjoint analysis was performed using the “conjoint” procedure in SPSS. Through a series of linear regressions, SPSS conjoint uses the rating of patient scenarios (dependent variable) from each participant to generate utility scores (the βs in a regression model) for each attribute level (independent variables). Utility scores represent participant preferences for that attribute level, with higher utility scores indicating greater preference.
Utilities were estimated in this study using ordinary least squares (OLS) regression. OLS procedure is the most appropriate when a study includes a dependent variable that is interval scaled. The OLS procedure also has the advantage of providing standard errors for the estimated parameters. The basic model of conjoint analysis that we used in our study was:

$$\gamma = \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \text{Constant} + \epsilon$$

Where: \(Y = \) respondent’s preference for the patient scenario, \(\beta_i = \) beta weights (utilities) for the levels, \(\epsilon = \) an error term.

The relative importance of each attribute as a whole is also calculated in percentage terms based on the beta weights. SPSS computes the importance score by taking the range of utility scores for any attribute level (highest minus lowest), dividing by the sum of all the utility ranges and multiplying by 100. Thus, SPSS conjoint provides two key inter-related pieces of information: (1) the relative importance of each attribute as a whole and (2) the utility preferences for each of the attribute levels.

A benefit coming from conjoint analysis is the ability to predict preference for a patient scenario that weren’t rated by the respondents. These are referred to as simulation cases. Simulation cases were included as part of the plan, along with the scenarios from the orthogonal design in the SPSS file. The preference probabilities of simulation cases gave us the predicted probabilities of choosing each of the simulation cases as the most preferred one, under three different probability-of-choice models. The first one is the maximum utility model, which determined the probability as the number of respondents predicted to choose the scenario divided by the total number of respondents. For each respondent, the predicted choice was simply the scenario with the largest total utility.

The second is The Bradley-Terry-Luce (BTL) model determined the probability as the ratio of a scenario’s utility to that for all simulation scenarios, averaged across all respondents. And the third model is the logit model, which is similar to BTL but uses the natural log of the utilities instead of the utilities themselves.
The previous conjoint model estimation was calculated from data generated at the individual level (for every participant for each attribute level of patient scenario) then averaged across all respondents to give estimates of aggregate data.

**Results**

Seven hundred and twenty three pediatric dentists submitted the online survey between May and June 2011 with a response rate of 32%. This response rate is within the range (25%-50%) of recent published response rates for national pediatric dentists’ surveys in the US.228-232

**Sample characteristics**

The study sample was approximately a 60:40 split regarding gender of the respondents, favoring males (58%). The mean age for the sample was 48 years (SD=12).

The majority of respondents worked in private practices (84%), in the suburbs of urban cities (48%) with only 9% working in the inner city and 1% in community or public health clinics. When pediatric dentists were asked about how busy their practices are, 49% of pediatric dentists selected “Provided care for all who requested appointments but was not overworked”. Table 1 provides additional data about the study sample.

The patient population served by our sample was mainly in the age group 3-6 years (35%), was financed by private insurance (51%), and had a significant group of patients at high risk for caries (47%). Table 2

**The pattern of ART use in this sample**

Among the 723 respondents who submitted the online survey, 15 % were unlikely to use ART with any of the presented nine patient’s scenarios. In contrast, 3% were very likely to use ART with all of the nine scenarios presented.

In addition, 82% considered ART to be an interim treatment for the presented scenarios and 18% considered ART to be a definitive treatment. Pediatric dentists cited several factors that influenced their decision regarding the therapeutic goals of ART
(definitive or interim), including “Caries risk of the patient” (61.1%), Depth of lesion” (60.4%), and “Number of surfaces involved, single or multiple” (56.4%). Table 2

Our sample reported having learned about ART as a restorative procedure mainly from advanced pediatric training (58.8%), the scientific literature (47.4%), and AAPD policies and guidelines (46.1%). However, for 3.5% of our respondents, our survey was the first time they had encountered ART. Table 3

Conjoint questions

As noted above, only 523 of the 723 respondents were included in the conjoint analysis. We removed those respondents who skipped one or more of the nine patients’ scenarios ratings (39 respondents) or respondents who showed zero variation among their ratings (161 respondents).

Model fit was assessed using correlation statistics that provide measures of the correlation between the observed and estimated preferences (223). In our study, Pearson’s R was 97% (p=.000); and Kendall tau was 83%, (p=.001), both of which indicate a good fit. We also validated our conjoint design with a Cramer’s V test, showing only weak correlations among the three design factors (either 0 or <.3). This is consistent with a main effects fractional factorial design we selected.

Figure 4 shows the results of the conjoint analysis demonstrating the propensity of pediatric dentists in this sample to use ART with their patients in a particular clinical presentation. There are two notable pieces of information in the figures: the first is utility scores that represent participant preferences for a factor level, with higher utility scores indicating greater preference; the second is the relative importance of each factor as a whole.

For example for factor “Age of the patient” ART was preferred for patients who are two years old. For the factor Cooperation, the preferred level “Uncooperative child” had a significantly higher utility or preference than the level “Cooperative child”. Under the factor Insurance coverage, the most preferred level was “without insurance”;
however, this result was not significantly different than the level “public insurance”, or the level “private insurance”. Confidence intervals of those utilities are presented in figure 5.

In terms of relative importance of factors, we can state that the most important factor prompting pediatric dentists to use ART with their patients for the presented clinical case was “Age”, with 40% importance, followed by the factor Cooperation, with an importance of 37%. In third place, with regard to importance, was the factor Insurance coverage (23%).

In addition to the previous two pieces of information, conjoint Analysis allows researchers to predict the most preferred patient scenario that prompts pediatric dentists to use ART with their patients, using the factors and the levels presented in the survey. The total utility for different combinations of the levels was calculated not only for the nine patients’ scenarios presented to respondents but also for all possible 27 combinations of the factors’ levels. Patient profile #3 serves as an example, in which total utility was the utility of age two (.546) + the utility of uncooperative child (.458) + the utility of child with no insurance (.124) + the constant (2.934) = 4.062. Among the 27 scenarios in this study, the highest utility was for scenario # 3 (A 2 year old patient who is uncooperative and has no insurance), which had a logit probability of 9.8%. In contrast, the least preferred patient scenario to use ART with was # 25 (A six year old patient who is cooperative and has public insurance) with a logit value of 1.1%. Table 4 shows selected patients’ scenarios, their total utilities, maximum utility, and their logit values.

In other words, if the 27 patient scenarios were real, most pediatric dentists will be most likely willing to treat patients in scenario # 3 with ART nine times more often than patients in scenario # 25.

**Response bias**

An email with a link to the web survey was sent to a random sample of 2237 pediatric dentists registered as pediatric dentistry specialists in the AAPD member list.
Seven hundred and twenty three pediatric dentists submitted the online survey; however, as we explained above, only 523 cases were eligible for the conjoint analysis. Response bias was checked in different steps to insure that our sample has fair representation of the AAPD specialist members.

The 523 eligible cases that were used in the conjoint analysis were compared with the original sample of 723 respondents and the AAPD specialist member list by age and gender using t-test and chi square and no statistical difference was detected.

Respondents who showed no variation in their rating of patients’ profiles

We remained concerned about the fact that there were 200 ineligible cases that were skipped by the conjoint analysis. Further investigation showed that Thirty-nine cases missed one or more of the preference ratings and 161 showed no variation among their rating responses; that means that they gave the same exact rating to all patients’ scenarios (on the 5 point scale). Those respondents were called non traders; they do not trade between different attributes or characteristics of a product, factor or a situation. The common practice is to exclude them from the analysis (208) because a conjoint model cannot be built for individuals who show no variance.

The characteristics of the non-traders were compared with traders (respondents who were included in the analysis), with the original sample and the whole AAPD specialist emailing list by different demographic and practice characteristics. In general, non-traders differed significantly from respondents who were included in the analysis (traders) by age, gender, and location and nature of the practice. Significant differences are reported in table 5.

Among the 161 non-traders, there were two very distinct groups, 111 respondents who selected “very unlikely to use ART” all the time with the nine patients’ scenarios and 23 respondents who selected “very likely to use ART” for each of the nine patients’
scenarios. A comparison between the two groups of the non-traders and the 111 subset of the non-traders and the traders are listed in table 6.

According to the non-traders two subsets bivariate analysis, our results showed that pediatric dentists who worked in academics, public health services, community centers and who worked in busy practices were willing to use ART all the time for the nine presented scenarios. In contrast, pediatric dentists who had private practices, worked in small cities and treated less Medicaid patients were not willing to use ART at all for the nine presented scenarios.

Additionally, the two groups differed significantly in considering ART in the presented patients’ scenarios as interim or definitive treatment, 56% of respondents who were very likely to use ART always considered using ART as definitive treatment “most of the time”. However, 4% of the respondents who were very unlikely to use ART all the time considered ART as a definitive treatment ($X^2=21, p=.000$). Table 7 shows the factors that influenced both groups’ decision to use ART as definitive or interim treatment.

**Discussion**

The literature describes substantial variation in dentists’ assessments of clinical, system and behavioral factors that influence their decisions to initiate a particular restorative treatment for their patients. The methods used to examine and report the factors influencing practitioner’s decision to select a restorative treatment option are often complicated by constraints of the conditions under which dentists were asked to make their assessments and thus limit inference to other settings. In contrast, conjoint data allow us to model choices under many different scenarios, under different constraints, and across any population. As such, they offer a flexible mechanism for not only evaluating the current situation, but also new, future, or even potential (hypothetical) situations.
Although marketing researchers, transportation economists, and health economists regularly use conjoint analysis, we are aware of only three studies applying these methods in oral health care research. Upon initial examination, conjoint analysis seems valuable to oral health care research. However, this will be more closely examined in the discussion of our results.

In general, clinical factors and dentists’ preferences probably drive most initial treatment decisions. To explore pediatric dentists’ preference of the use of ART with their pediatric patients, we controlled for the clinical presentation of the carious lesion (deep into the dentin without pulp involvement), the type of dentition (primary) and the location of the tooth (anterior tooth). This clinical presentation is a good candidate for ART restoration; using ART in such a cavity has a high survival rate and conforms to the ADA specification for a good quality restoration.

Controlling for clinical factors allowed us to investigate other systematic and behavioral factors such as age, cooperation and insurance converge that may influence the decision to use ART with pediatric patients. Those factors play an important role in marketing the use of ART as an affordable, atraumatic, and patient friendly procedure for whom traditional dental care is not feasible.

We hypothesized that that pediatric dentists’ propensity to use ART is higher for younger children, for uncooperative children, and those without insurance.

As predicted, the age of the child had the biggest impact on pediatric dentists' decisions to use ART, compared to level of cooperation and type of insurance coverage. This was in line with other studies that listed age as an important factor in practitioners’ decision to initiate a restorative treatment in general and with the AAPD guidelines indicating that treating very young children is an important condition for the use of ART or ITR. Our conjoint data showed that the preference or willingness to use ART with patients at age two is significantly higher than age 4 and age 6. Children at age 2 may not
be prepared for the pharmacological behavior management that is usually needed for more conventional restorative options.

Level of cooperation came second in importance after age factor. This also agrees with previous reports regarding factors that influence dentists’ decision on selecting treatment modalities. Pediatric dentists had a significantly higher preference for using ART with an uncooperative child than a cooperative child. This is also in line with the AAPD recommendations on the use of ART or ITR with uncooperative children, for whom the traditional restorative treatment would be difficult.

Finally, conjoint results showed that pediatric dentists were more willing to use ART with children with no insurance compared to children with private insurance or on public assistance. However, this result was not statistically significant; none the less, it suggests the appropriateness of ART treatment for a very important segment in the population, the uninsured, which consists 23% of the children in the US. 235

Interestingly and in contrast with other reports, 212-214 where insurance coverage usually selected by a small percentage (usually < 10%) of respondents as a detrimental important factor in restorative treatment decision making, in conjoint results it scored an importance value of 23%. Despite the social pressure that was at its peak at the time the survey was sent out, our results found that insurance status still had a big impact on pediatric dentists’ decision to use ART with their child patients. On May 23rd after few days of the first survey email was sent out, a research study that directly measured dentists' willingness to schedule an appointment for a child for an emergency dental trauma in the second-largest US urban county, Cook County, was published in Pediatrics Journal on-line. This study found that Illinois dentists, including those participating in Medicaid, were less likely to see a child for an urgent dental complaint if the child has public versus private dental coverage. This study had a large media and public reaction and was featured in many magazines and primetime shows.
In general, when we ran the simulation analysis to see which patient scenario was most preferred, pediatric dentists were most likely to use ART with patients at age two, who were uncooperative, and had no insurance. In contrast, our pediatric dentist participants were least likely to use ART with patients at age 6, who were cooperative and covered by public insurance. Given this result, it seems pediatric dentists’ inclination to use ART in the US agrees perfectly with AAPD guidelines on the use of ART or ITR for very young and uncooperative children \(^{144}\) and the global organizations’ endorsement of ART as an affordable and Atraumatic procedure. \(^{176}\) Although some literature in the US found the use of ART is effective with children covered by public insurance, \(^{116}\) those children, because of their extensive restorative needs, they are usually sent to the operating room for more definitive and conventional restorative treatment. \(^{236}\)

Six hundred and ninety four respondents answered the question “In the previous scenarios, did you consider ART as a definitive or interim treatment?” with 82% considering ART to be an interim treatment most of the time. This is in line with our earlier work on the use of ART in pediatric dentistry training institutions, in which 57% of pediatric dentistry residency programs \(^{185}\) and 83% of pre-doctoral pediatric dentistry programs chairs considered ART to be an interim treatment in primary teeth. \(^{237}\) Different from how ART is viewed globally as a definitive treatment, it seems ART in the US is used mainly as an interim treatment which makes its public health value less to populations that cannot afford the more definitive restorative treatment.

The question about factors influencing pediatric dentists’ use of ART as an interim or a definitive treatment included clinical and non-clinical factors and used a “check all that apply” format. The responses were similar to the factors that influenced their willingness to use ART in the first place and also similar to factors that influence the restorative treatment decision reported in the literature. \(^{122, 212, 213, 233}\) Age and cooperation scored the highest percentages, even higher than other clinical characteristics of the lesion. In addition, insurance coverage that scored 23% importance in the conjoint
results was selected only by 9% as a factor that may influence their decision to use ART as definitive or interim. This clearly demonstrates the value of conjoint as a method to offset the impact of social pressure.

Advanced pediatric dentistry training, scientific literature and AAPD guidelines were the most cited sources from which our respondents learned about ART. This was in line with our earlier work \cite{185, 237} that showed that program directors and chairs, who considered those resources as very important in discussing restorative treatment options with their students or residents, provided more training on ART.

The 523 respondents who were included in the conjoint analysis did not differ significantly from the AAPD 4552 pediatric dentists emailing list by age and gender or than the original sample of 723 who submitted the on-line survey by demographic and practice characteristic data. In addition our response rate was with in the normal range of pediatric dentists’ recent surveys response rates especially the ones that discussed controversial topic such as dental therapists’ model \cite{231} and adoption of new behavioral guidelines. \cite{229}

One interesting result that we had from our analysis was the “Non-traders”; those respondents were not included in the conjoint analysis because they didn’t show any variation in their rating of the patients’ scenarios. The majority of non-traders were unlikely to use ART all the time for the nine scenarios. Such respondents seem to be not willing to use ART as a restorative treatment option, at least over the range of factors shown in our experimental design. Some of these subjects may be willing to choose to preform ART under different scenarios than they were shown, while others may not choose to use ART under any conditions because of an attitude or a belief about the efficiency of ART.

Those respondents differed significantly in demographic and practice characteristic data from those who were willing to use ART at different degrees of preference. Those who chose not to use ART with any of the nine scenarios tended to be
older, which may be explained by ART being relatively a new concept in dental care.\textsuperscript{163,80} They also differed significantly on how they view ART as definitive or interim treatment and on all factors that may influence this decision.

This group also differed significantly from respondents who were willing to use ART at different degrees of preference by how they learned about ART; a smaller percentage learned about ART in advanced pediatric dentistry programs or scientific literature and for a higher percentage this was the first time to hear about ART.

In contrast, respondents who chose to use ART all the time with the nine scenarios tend to work more in academics, public health services and community centers settings than those who were unlikely to use ART in any of the presented scenarios. This is expected in these settings, which mainly serve patients who are at high caries risk and patients who cannot afford the traditional restorative treatment; in both cases ART with its low cost\textsuperscript{176} and ability to stabilize disease may be a good option for those patients. In addition, there was a suggestive result ($t=-2$, $p=.06$) that pediatric dentists who were likely to use ART all the time treated more patients covered by public insurance than those who were unlikely to use ART at all. A 2001 national study of pediatric dentists’ caries management techniques showed that placing GI to restore cavities is more effective with Medicaid patients.

Although we could not detect a response bias in our sample using mainly demographic data, we cannot exclude the possibility of selection bias. It seems likely that pediatric dentists who are practicing ART or interested in this procedures were most probably the ones who answered the survey. This in turn, however, suggests the actual rate of use to be lower than we have estimated.

Furthermore, our study results are limited to the factors and levels we selected to be included in the hypothetical scenarios. Deciding on the number of factors and levels to be included in the conjoint design is one of the major challenges to produce a feasible design that achieve statistical efficiency but at the same time does not cause information
overload. This required the options included in the patients’ scenarios to be realistic and important contextual factors to be included in the model. 220

Another important limitation was the presentation of the conjoint questions; in our study, we used a matrix to rate the nine scenarios on a five point scale. However, the ideal method to present conjoint questions is to present each scenario in one screen. This may contributed to the high number of non-traders. On the other hand the use of matrix saved respondents the time and the trouble to move to new screen with each new scenario.

Future research is needed to validate our conclusions regarding the appropriateness of conjoint analysis to assess dentists’ restorative treatment decisions. This may be achieved by asking questions on a variety of restorative modalities and assess the relative importance practitioners place on different factors that constitute a real patient situation. It will be even better if we can ask the same question in a simple ranking task and in a conjoint task, which might help to assess the differences produced by different tasks and if this difference is of any practical significant on future policy or guideline development.

**Conclusion**

This study demonstrates the feasibility of using methods from marketing research and economics, such as conjoint analysis, to determine the relative importance practitioners place on different factors that may influence their decision to use ART. Overall, the most critical finding was that being very young and/or uncooperative were the most important reasons practitioners reported a higher likelihood of using ART. Although insurance coverage was the least important factor overall, being without insurance was identified as an additional determining factor in decisions to use ART in this conjoint analysis.
List of all active members who registered as specialists in the AAPD (4533)

An email invitation with the survey link sent to a random sample of 50% of the whole population (2266)

29 email addresses were not valid which made our sample (2237)

Pediatric dentists who submitted the on-line survey (723)

Eligible surveys available for conjoint analysis (523)

Figure 3 Step by step sampling procedure for Study III
Figure 4 The conceptual model of our conjoint study including the three factors and their levels.
Figure 5 Steps in constructing the conjoint design for this study adapted from ISPOR\textsuperscript{209}
<table>
<thead>
<tr>
<th>Demographic and practice characteristics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>48</td>
</tr>
<tr>
<td>Gender: % of Females</td>
<td>42%</td>
</tr>
<tr>
<td>Location of practice: inner city</td>
<td>13%</td>
</tr>
<tr>
<td>Location of practice: urban but not inner city</td>
<td>15%</td>
</tr>
<tr>
<td>Location of practice: suburbs</td>
<td>48%</td>
</tr>
<tr>
<td>Location of practice: small city</td>
<td>15%</td>
</tr>
<tr>
<td>Location of practice: rural</td>
<td>0%</td>
</tr>
<tr>
<td>Nature of practice: private practice</td>
<td>85%</td>
</tr>
<tr>
<td>Nature of practice: hospital</td>
<td>3%</td>
</tr>
<tr>
<td>Nature of practice: Military</td>
<td>7%</td>
</tr>
<tr>
<td>Nature of practice: academic</td>
<td>1%</td>
</tr>
<tr>
<td>Nature of practice: public health services</td>
<td>2%</td>
</tr>
<tr>
<td>Nature of practice: community centers</td>
<td>2%</td>
</tr>
<tr>
<td>Busyness of practice on a scale of 1 to 4 (1 is the busiest)</td>
<td>2.63</td>
</tr>
<tr>
<td>Board certified</td>
<td>58%</td>
</tr>
<tr>
<td>Mean % of patients treated by the practice covered by public assistance</td>
<td>34%</td>
</tr>
<tr>
<td>Mean % of patients treated by the practice covered by private insurance</td>
<td>51%</td>
</tr>
<tr>
<td>Mean % of patients treated by the practice covered by no insurance</td>
<td>16%</td>
</tr>
</tbody>
</table>

Table 20 Demographic and practice characteristics of the original sample of the 723 pediatric dentists who submitted the online survey
<table>
<thead>
<tr>
<th>Factors</th>
<th>Valid Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperation of child</td>
<td>80.0%</td>
</tr>
<tr>
<td>Age of child</td>
<td>75.9%</td>
</tr>
<tr>
<td>Caries risk of the patient</td>
<td>61.1%</td>
</tr>
<tr>
<td>Depth of lesion</td>
<td>60.4%</td>
</tr>
<tr>
<td>Number of surfaces involved (single or multiple)</td>
<td>56.4%</td>
</tr>
<tr>
<td>Number of cavities present in child’s mouth</td>
<td>55.0%</td>
</tr>
<tr>
<td>Location of the tooth (anterior or posterior)</td>
<td>49.9%</td>
</tr>
<tr>
<td>Tooth surface involved (smooth or fissure)</td>
<td>44.7%</td>
</tr>
<tr>
<td>Insurance coverage of patient</td>
<td>8.7%</td>
</tr>
</tbody>
</table>

Table 22 Factors influenced pediatric dentists’ use of ART as definitive or interim treatment in primary teeth (check all that apply format)
Table 21 Sources of knowledge about ART among our sample of 723 pediatric dentists (check all that apply format)
Figure 6: Results of utility estimates of the levels of the three factors, Age, Cooperation level and Insurance coverage and the importance values of each factor.
Figure 7 the confidence intervals (CI) of the factors’ levels’ utility estimates.
<table>
<thead>
<tr>
<th>ID # of Patient Scenario</th>
<th>Patient’s scenario as presented for pediatric dentists</th>
<th>Total utility</th>
<th>Maximum utility</th>
<th>Logit value</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>A 2 year old patient who is uncooperative and has public insurance</td>
<td>3.8</td>
<td>0%</td>
<td>7.6%</td>
</tr>
<tr>
<td>#2</td>
<td>A 2 year old patient who is uncooperative and has private insurance</td>
<td>3.9</td>
<td>0%</td>
<td>8.6%</td>
</tr>
<tr>
<td>#3</td>
<td>A 2 year old patient who is uncooperative and has no insurance</td>
<td>4.1</td>
<td>100%</td>
<td>9.8%</td>
</tr>
<tr>
<td>#9</td>
<td>A 2 year old patient who is cooperative and has no insurance</td>
<td>3.159</td>
<td>0%</td>
<td>4.0%</td>
</tr>
<tr>
<td>#10</td>
<td>A 4 year old patient who is uncooperative and has public insurance</td>
<td>3.189</td>
<td>0%</td>
<td>4.1%</td>
</tr>
<tr>
<td>#12</td>
<td>A 4 year old patient who is uncooperative and has no insurance</td>
<td>3.4</td>
<td>0%</td>
<td>5.2%</td>
</tr>
<tr>
<td>#19</td>
<td>A 6 year old patient who is uncooperative and has public insurance</td>
<td>2.8</td>
<td>0%</td>
<td>2.8%</td>
</tr>
<tr>
<td>#25</td>
<td>A six year old patient who is cooperative and has public insurance</td>
<td>1.9</td>
<td>0%</td>
<td>1.1%</td>
</tr>
<tr>
<td>#27</td>
<td>A 6 year old patient who is cooperative and has no insurance</td>
<td>2.2</td>
<td>0%</td>
<td>1.4%</td>
</tr>
</tbody>
</table>

Table 22  Examples of Patient Scenarios, the Total Utility, Maximum Utility and Logit Values of Selected Patients’ Scenarios
Table 23 A Comparison Between Non-traders and Traders, the Original Sample and the Whole AAPD List by Demographic and Practice

<table>
<thead>
<tr>
<th>Demographic and practice characteristics</th>
<th>Non-traders: respondents who had no variation among their ratings of the nine patients’ profiles and were not used in the conjoint analysis (161)</th>
<th>Traders: Respondents who were used in the conjoint analysis (523)</th>
<th>The original sample: pediatric dentists who submitted the online survey (723)</th>
<th>The whole AAPD list of pediatric dentists (4552)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>50</td>
<td>47&lt;sup&gt;1&lt;/sup&gt;</td>
<td>48</td>
<td>47&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Gender: % of Females</td>
<td>35%</td>
<td>45%&lt;sup&gt;1&lt;/sup&gt;</td>
<td>42%</td>
<td>44.8%&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>Location of practice: inner city</td>
<td>11%</td>
<td>13%</td>
<td>13%</td>
<td>-</td>
</tr>
<tr>
<td>Location of practice: urban but not inner city</td>
<td>13%</td>
<td>16%</td>
<td>15%</td>
<td>-</td>
</tr>
<tr>
<td>Location of practice: suburbs</td>
<td>48%</td>
<td>48%</td>
<td>48%</td>
<td>-</td>
</tr>
<tr>
<td>Location of practice: small city</td>
<td>21%</td>
<td>13%&lt;sup&gt;2&lt;/sup&gt;</td>
<td>15%&lt;sup&gt;3&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Location of practice: rural</td>
<td>0.6%</td>
<td>0%</td>
<td>0%</td>
<td>-</td>
</tr>
<tr>
<td>Nature of practice: private practice</td>
<td>92.5%</td>
<td>83%&lt;sup&gt;4&lt;/sup&gt;</td>
<td>85%&lt;sup&gt;5&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td>Nature of practice: hospital</td>
<td>5%</td>
<td>3%</td>
<td>3%</td>
<td>-</td>
</tr>
<tr>
<td>Nature of practice: Military</td>
<td>0.6%</td>
<td>1%</td>
<td>7%</td>
<td>-</td>
</tr>
<tr>
<td>Nature of practice: academic</td>
<td>0.6%</td>
<td>7%</td>
<td>1%</td>
<td>-</td>
</tr>
<tr>
<td>Nature of practice: public health services</td>
<td>0.6%</td>
<td>2%</td>
<td>2%</td>
<td>-</td>
</tr>
<tr>
<td>Nature of practice: community centers</td>
<td>0.6%</td>
<td>3%</td>
<td>2%</td>
<td>-</td>
</tr>
<tr>
<td>Busyness of practice on a scale of 1 to 4 (1 is the busiest)</td>
<td>2.65</td>
<td>2.65</td>
<td>2.63</td>
<td>-</td>
</tr>
<tr>
<td>Board certified</td>
<td>58%</td>
<td>57%</td>
<td>58%</td>
<td>-</td>
</tr>
<tr>
<td>Mean % of patients treated by the practice covered by public assistance</td>
<td>32%</td>
<td>35%</td>
<td>34%</td>
<td>-</td>
</tr>
<tr>
<td>Mean % of patients treated by the practice covered by private insurance</td>
<td>55%</td>
<td>51%</td>
<td>51%</td>
<td>-</td>
</tr>
<tr>
<td>Mean % of patients treated by the practice covered by no insurance</td>
<td>16%</td>
<td>16%</td>
<td>16%</td>
<td>-</td>
</tr>
</tbody>
</table>

Significantly different when compared with the Non-traders: <sup>1</sup> t=2.7, p=.008  <sup>2</sup> X<sup>2</sup>=5.1, p=.02  <sup>3</sup> X<sup>2</sup>=6.5, p=.011  <sup>4</sup> X<sup>2</sup>=8.8, p=.003  <sup>5</sup> X<sup>2</sup>=4.1, p=.04  <sup>6</sup> X<sup>2</sup>=7, p=.008  <sup>7</sup> t=3.1, p=.002  <sup>8</sup> X<sup>2</sup>=5.6, p=.018
<table>
<thead>
<tr>
<th>Demographic and practice characteristics</th>
<th>Respondents who chose not to use ART all the time (111)</th>
<th>Respondents who chose to use ART all the time (23) Column A</th>
<th>Respondents who were included in the conjoint analysis, the traders (523) Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>49.8</td>
<td>50</td>
<td>47(^4)</td>
</tr>
<tr>
<td>Gender: % of Females</td>
<td>34%</td>
<td>30%</td>
<td>46%(^9)</td>
</tr>
<tr>
<td>Location of practice: inner city</td>
<td>10%</td>
<td>23%</td>
<td>13%</td>
</tr>
<tr>
<td>Location of practice: urban but not inner city</td>
<td>11%</td>
<td>14%</td>
<td>16%</td>
</tr>
<tr>
<td>Location of practice: suburbs</td>
<td>52%</td>
<td>31%</td>
<td>48%</td>
</tr>
<tr>
<td>Location of practice: small city</td>
<td>23%</td>
<td>5% (^1)</td>
<td>13%(^{10})</td>
</tr>
<tr>
<td>Location of practice: rural</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Nature of practice: private practice</td>
<td>97%</td>
<td>70% (^2)</td>
<td>83% (^{11})</td>
</tr>
<tr>
<td>Nature of practice: hospital</td>
<td>0.9%</td>
<td>0</td>
<td>3%</td>
</tr>
<tr>
<td>Nature of practice: Military</td>
<td>0</td>
<td>0</td>
<td>7%</td>
</tr>
<tr>
<td>Nature of practice: academic</td>
<td>1%</td>
<td>17% (^{3})</td>
<td>1% (^{12})</td>
</tr>
<tr>
<td>Nature of practice: public health services</td>
<td>0</td>
<td>8% (^4)</td>
<td>2%</td>
</tr>
<tr>
<td>Nature of practice: community centers</td>
<td>0</td>
<td>4% (^{5})</td>
<td>3%</td>
</tr>
<tr>
<td>Busyness of practice on a scale of 1 to 4 (1 is the busiest)</td>
<td>2.7</td>
<td>2.1(^{6})</td>
<td>2.62</td>
</tr>
<tr>
<td>Board certified</td>
<td>55%</td>
<td>65%</td>
<td>57%</td>
</tr>
<tr>
<td>Mean % of patients treated by the practice covered by public assistance</td>
<td>30%</td>
<td>42% (^{7})</td>
<td>35%</td>
</tr>
<tr>
<td>Mean % of patients treated by the practice covered by private insurance</td>
<td>55%</td>
<td>49%</td>
<td>51%</td>
</tr>
<tr>
<td>Mean % of patients treated by the practice covered by no insurance</td>
<td>16%</td>
<td>17%</td>
<td>16%</td>
</tr>
</tbody>
</table>

\(^2\) \(X^2=4, p=.04\) \quad \(^3\) \(X^2=21, p=.000\) \quad \(^4\) \(X^2=14, p=.000\) \quad \(^5\) \(X^2=5, p=.027\) \quad \(^6\) \(X^2=38, p=.000\) \quad \(^7\) \(t=2, p=.06\) \quad \(^8\) \(t-test=3, p<.009\) \quad \(^9\) \(X^2=6, p<.012\) \quad \(^{10}\) \(X^2=8, p<.005\) \quad \(^{11}\) \(X^2=15, p<.000\) \quad \(^{12}\) \(X^2=6, p<.011\)

Table 24 A Comparison between Non-traders Who Were Not Willing to Use ART with Any of the Scenarios and Column A, the Non-Traders Who Were Willing to Use ART with All the Scenarios and Column B, the Traders Who Were Willing to Use ART at Different Levels
Table 27 The differences in factors influencing pediatric dentists’ decision to use ART as definitive or interim treatment between the two subsets of the non-traders; the ones who were not willing to use ART with any of the scenarios and the ones who were willing to use ART with all the scenarios.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Respondents who chose not to use ART all the time (111)</th>
<th>Respondents who chose to use ART all the time (23)</th>
<th>$\chi^2$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caries risk of the patient</td>
<td>30%</td>
<td>70%</td>
<td>$\chi^2=15, p=.000$</td>
<td></td>
</tr>
<tr>
<td>Number of cavities present in child’s mouth</td>
<td>22%</td>
<td>57%</td>
<td>$\chi^2=12, p=.001$</td>
<td></td>
</tr>
<tr>
<td>Insurance coverage of patient</td>
<td>4%</td>
<td>4%</td>
<td>No significant difference</td>
<td></td>
</tr>
<tr>
<td>Depth of lesion</td>
<td>30%</td>
<td>61%</td>
<td>$\chi^2=8, p=.004$</td>
<td></td>
</tr>
<tr>
<td>Age of child</td>
<td>34%</td>
<td>70%</td>
<td>$\chi^2=10, p=.002$</td>
<td></td>
</tr>
<tr>
<td>Cooperation of child</td>
<td>32%</td>
<td>70%</td>
<td>$\chi^2=11, p=.001$</td>
<td></td>
</tr>
<tr>
<td>Number of surfaces involved (single or multiple)</td>
<td>26%</td>
<td>65%</td>
<td>$\chi^2=13, p=.000$</td>
<td></td>
</tr>
<tr>
<td>Location of the tooth (anterior or posterior)</td>
<td>25%</td>
<td>48%</td>
<td>$\chi^2=5, p=.03$</td>
<td></td>
</tr>
<tr>
<td>Tooth surface involved (smooth or fissure)</td>
<td>20%</td>
<td>64%</td>
<td>$\chi^2=28, p=.000$</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 7: DISCUSSION

Introduction

The three studies that comprise this dissertation are among the first to examine the factors related to the use of Atraumatic Restorative Treatment (ART) in pre-doctoral dental education, advanced pediatric dentistry training and in pediatric dentistry practices in the US.

Using a web-survey, post-doctoral pediatric dentistry program directors, pre-doctoral pediatric dentistry program directors and pediatric dentists were questioned about the use of ART in pediatric dental education and in dental practices in the US. This was important to provide us with insights on the extent of the use of this procedure and to explore the attitude of educators and practitioners towards ART.

After searching the literature for factors that may influence dentists’ and dental educators’ decisions to select restorative treatment, a main hypothesis for study I and II was formulated. It was hypothesized that were certain program directors’ characteristics, program characteristics, and patient population characteristics that influence the attitude of program directors and the level of didactic and clinical instruction they provide on ART in their programs.

In the third study, a conjoint design was adopted to elicit the relative importance that pediatric dentists place on different factors when they decide to use ART with their patients. The age of the child, his or her level of cooperation and their insurance status were the three factors used in this design.

This section will summarize our findings from the three studies by first descriptively comparing the teaching of ART in pre and post-doctoral pediatric dentistry programs (e.g. clinical training, didactic instruction and attitude of program directors) and then discuss the factors that influenced pediatric dentists to be more willing to use ART with their patients.
clinical training on ART in pre and post-doctoral pediatric dentistry programs (Studies I and II)

The clinical training on ART as a dental caries management technique was provided more often in post-doctoral pediatric dentistry programs than pre-doctoral pediatric dentistry programs. Pre-doctoral program directors who didn’t include ART in their curriculum justified this by citing the following reasons: “The unavailability of the appropriate dental materials”, “No space in the curriculum”, “Students need to learn the ideal restoration first” and “Insufficient scientific evidence that support the use of ART.”

In contrast, post-doctoral pediatric dentistry program directors found that “The non-existence of special ADA code for ART” was a real obstacle to include the provision of ART restorations in their programs.

The attitude of the directors predicted the level of training in both pre- and post-doctoral programs; however, the two types of programs differed in how the use of pharmacological behavior management techniques predicted their level of clinical training. In post-doctoral pediatric dentistry programs, where treating children under general anesthesia is a requirement for the specialty, greater use of general anesthesia was associated with more training on ART. The correlation between ART and greater usage of general anesthesia can be explained by the way that ART is utilized for those patients.

In programs that use general anesthesia more often, ART functions as a method of dental caries stabilization for children waiting for their turn in the operating rooms. In contrast, pre-doctoral programs, where operating on children under general anesthesia or other pharmacological behavioral management techniques is rare, there is less need for such stabilization using ART, and thus, it is less likely that there would be an association between these two factors.

In both types of programs, ART was mainly used as an interim treatment and as a restoration that was used more often in anterior teeth, in primary teeth and for single-surface lesions.
Didactic instruction on ART in pre and post-doctoral pediatric dentistry programs (Studies I and II)

Both types of programs provided didactic instruction on ART; however, it seems that the post-doctoral pediatric dentistry program emphasized more often that “Preparing cavities using only hand excavators is a proper technique in certain situations”. Most of didactic instruction in pre-doctoral programs was in the lecture format while in post-doctoral programs it was in the form of assigned readings and small group discussions. In both populations, programs that treated older children (e.g. 6 to 12 or older than 13 years old) more often provided less didactic instruction on ART.

Attitude of program directors towards ART

Pre-doctoral pediatric dentistry program directors showed a more positive attitude towards ART than post-doctoral pediatric program directors; the sample of pre-doctoral program directors included more people with less negative attitude than post-doctoral program directors. In final regression model, post and pre-doctoral program directors who considered professional guidelines an important factor when discussing restorative treatment in pediatric dentistry clinics had a more positive attitude towards ART. In addition, post-doctoral program directors who believed that patient insurance and his caries risk are were important factor in selecting treatment options, showed a more positive attitude towards ART training. Directors in both pre and post-doctoral programs who strongly disagreed with that” Definitive restorations should be the treatment of choice regardless of other factors” showed more positive attitude towards ART.

Factors that influenced the decision of pediatric dentists to use ART in anterior primary teeth (Study III)

Using conjoint design to build patients’ scenarios and present them to respondents, study III results suggest that pediatric dentists in the US were more willing to use ART with very young children, uncooperative children and children without insurance.
Among the 723 pediatric dentists, 3% were willing to use ART in all nine of the patient scenarios, while, 15% were unwilling to use ART for any of those same scenarios. The previous two groups differed significantly in demographic and practice characteristics and on how they learned about ART.

In general, pediatric dentists viewed ART as an interim treatment most of the time. This was because of several factors; however, the most cited ones were the child’s caries risk, depth of lesions, and the number of surfaces involved in treatment.

Our sample reported having learned about ART as a restorative procedure mainly from advanced pediatric training, scientific literature, and AAPD policies and guidelines. However, for 3.5% of our respondents, our survey was the first time they had encountered ART.

**General discussion**

In spite of strong evidence that supports ART’s effectiveness, this technique still faces some resistance among dental educators and practitioners. This resistance occurs mainly due to lack of knowledge about the technique and about the concept of minimal intervention. Advanced pediatric dentistry training programs and pre-doctoral dental education are very important sources for dentists, particularly pediatric dentists, to learn about ART, and AAPD guidelines are very influential factors that prompt educators and practitioners to use ART. Thus, it is logical to think that professional organizations should be at the forefront of efforts to promote the use of ART in the US.

From the three studies, it is evident that practitioners in the U.S. use ART in ways that differ from its original therapeutic goals. In the early studies, ART was mainly placed in posterior, permanent teeth and served as a definitive treatment. Recent global research investigated the use of ART in anterior teeth and in primary teeth and reported encouraging results. The present research found that ART was used mainly in anterior primary teeth in pre- and post-doctoral dental education programs in the U.S., and the three studies agreed that the main use of ART in the US was as an interim treatment.
Thus, it appears that the pediatric dentistry community in the U.S. may view the use of ART differently than in the rest of the world. This was shown in our results where 31% of post-doctoral pediatric dentistry programs directors and 36% of pre-doctoral pediatric dentistry program directors “strongly agreed” or “somewhat agreed” that ART should be modified to conform to the oral health standards in the US.

This other version of ART was described by the AAPD in its 2008 revision of its policy statement about ART, which recognized two different therapeutic types of ART: Interim Therapeutic Restorations (ITR) and the Atraumatic Restorative Technique (ART). ITR was recommended by AAPD to be used in very young patients, uncooperative patients, patients with special health care needs for 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. On the other hand, ART was defined by the AAPD as “a means of restoring and preventing caries in populations that have little access to traditional dental care and necessarily functions as definitive treatment”. Thus, with this statement, the AAPD endorsed the idea of using ART primarily as an interim treatment.

AAPD is a valuable source of information about different restorative treatment modalities and practice guidelines. Our results from studies I and II showed that 97% of post-doctoral pediatric dentistry program directors and 95% of pre-doctoral pediatric dentistry program directors believed that professional guidelines were “very important” or “important” in restorative treatment selection decision. In study III, 46% of pediatric dentists, learned about ART from the AAPD guidelines, 59% from advanced pediatric dentistry training and 45% from pre-doctoral dental education.

Another important point to consider when trying to promote the use of ART is the nonexistence of any specific ADA treatment codes that would facilitate provider reimbursement for providing ART treatment. Such a code would encourage the use of ART, and thus may enable costs of care to be reduced through the use of ART,
particularly in public health and public insurance programs, as well as patient out of pocket costs. Results of study I and II showed that 78% of post-doctoral program directors and 77% of pre-doctoral program directors believed that ART could help in addressing problems related to access to oral care.

**Study implications**

In the US oral health care system, ART could be a valuable solution for children, especially the underserved, and it may meet their treatment needs in three ways:

1. ART may be a good option for children without insurance. In study III, our sample of pediatric dentists were more willing to use ART for children with no insurance more often than for children with private or public insurance. The reduced cost of ART compared to more traditional treatments, makes it more affordable for parents to pay for their children’s treatments. Similarly, results in studies I and II showed that 53% of the post-doctoral program pediatric dentistry program directors and 71% of pre-doctoral pediatric dentistry program directors, thought that ART can be a valid treatment option for children with limited financial resources. Another reason that makes ART a viable alternative treatment for children without insurance is that those children who lack regular care often have extensive treatment needs, and a caries stabilization technique such as ART may be a practical means of “buying time” until their caries risk can be lowered. In short, ART is a sound procedure that has good scientific evidence to support its safe and effective use, and could be a solution to increase provision of dental care for those underserved populations in the US.

2. ART may be a good additional component to community and school based prevention and restorative programs. In addition to being a minimally invasive restorative option that can be carried out in field settings, ART has a preventive aspect. This is achieved through sealing adjacent pits and fissures prone to develop caries by pressing the excess restorative material (GI) into the fissures
using finger pressure. Equally important, when well trained, other, non-dentist members in the oral health care team can apply ART in community and school settings, which could add to the cost effectiveness of such community based programs. Finally, the use of only manual instruments in ART minimize the need for sophisticated infection control measures, which makes ART ideal for such field settings.

3. Third, the application of ART in the US may have a great impact on minimizing the costs and the risks of sending very young children to the operating room to carry out dental work under general anesthesia. Recently, there has been much media attention about preschoolers who end up in the operating room for dental restorative treatment where general anesthesia is necessary for these very young uncooperative children. Conjoint results in study III showed that pediatric dentists in our sample were more willing to use ART with uncooperative and very young children. Similarly, our results from study I and II showed that the majority of post-doctoral program directors and pre-doctoral program directors believed that ART can be effective in treating very young children and are a good option for high caries risk children with multiple cavitated carious lesions. If ART could be used to stabilize the disease, then dental practitioners and care givers can work to try to modify the child’s behavior and lifestyle to reduce caries risk and better manage the disease, rather than merely treating the symptoms. This is an important point to be emphasized, because sending children to the operating room is only a cure for the symptoms (cavities), but not the diseases; research shows that most of children who undergo restorative treatment under general anesthesia return develop more cavities in less than two years. ART as a caries stabilization technique, with its atraumatic approach, could save costs and the risks associated with going to the operating room for dental treatment.
The Atraumatic Restorative Treatment was developed following the MID principles of preserving the tooth structure and preventing further disease. What started as an alternative resource for outreach situations became one of the most flexible methods for caries removal and restoration of the cavity in many private dental offices worldwide.

Supported by considerable advantages such as being a relatively painless procedure, having reasonable cost-benefits relationships, and being feasible and sustainable in outreach situations, the Atraumatic Restorative Treatment approach stands as an excellent alternative method for treating carious lesions in a diverse variety of situations, ranging from rural settings to a modern pediatric clinic. However, a judicious selection of the cavities and the restorative materials is always important for any restorative technique to achieve optimum results.

In Summary, the results of the 3 studies are considered exploratory; however, they provided us with insights on how ART is viewed and applied in the educational settings and dental practices in the US. Any future attempts to market this procedure as a solution for people who have problems with accessing dental care will benefit from these results as a first step to know where we are from complete incorporation of ART in our oral health care system.
CHAPTER 8: CONCLUSIONS

Introduction
This study examined the factors related to the use of ART in dental education, advanced pediatric dentistry training and in pediatric dentistry dental practice in the US.

In the US, ART is taught mainly as an interim restoration, in primary teeth, in anterior teeth and in single-surface restorations. The material of choice with ART restorations was GI.

The attitude of program directors in both pre and post-pediatric dentistry programs was a major predictor for the variation in the level of clinical training on ART provided in pediatric dentistry student and resident clinics. The majority of the directors showed a neutral to slightly positive attitude. However, directors who did not include ART in their curriculums showed a negative attitude towards ART and were unaware of the scientific evidence behind ART.

The unavailability of the appropriate dental materials and the non-existence of special ADA code for ART, remain two challenges that make it difficult for program directors to include ART training in the pediatric dentistry clinics.

Summary of the results of the three studies
Results of our studies can be summarized as follow:

1. Eighty eight percent of Pediatric Dentistry Residency programs in the US provided clinical training on ART; however 30% only of those programs used ART “Very Often/ Often” as a caries management technique for their pediatric patients.
2. Pediatric Dentistry residency programs used ART mainly in primary, anterior, single surface cavities and as interim treatment.
3. Attitudes toward ART alone and with control of other variables explained 35% of the level of training on ART.
4. Professional guidelines and insurance coverage were two of the strongest predictor of program director attitude.

5. Sixty-six percent of pre-doctoral pediatric dentistry programs in the US provided clinical training on ART; however only 14% of those programs used ART “Very Often/Often” as a caries management technique for their pediatric patients.

6. Pre-doctoral pediatric dentistry programs used ART mainly in primary, anterior, single surface cavities and as interim treatment.

7. The importance of professional guidelines as a factor in selecting treatment options, explained 41% of the variation in the attitude of program directors toward ART and 27% of the variation in the level of clinical training on ART provided to pre-doctoral students.

8. Conjoint analysis showed that being very young and/or uncooperative were the most important reasons practitioners reported a higher likelihood of using ART. Although insurance coverage was the least important factor overall, being without insurance was identified as an additional important factor in decisions to use ART.

9. In our sample of pediatric dentists, 82% considered ART to be an interim treatment for the presented scenarios and 18% considered ART to be a definitive treatment, in addition, 15% were unlikely to use ART with any of the presented nine patient’s scenarios. In contrast, 3% were very likely to use ART with all of the nine scenarios presented.

10. Pediatric dentists in our sample reported having learned about ART as a restorative procedure mainly from advanced pediatric training (58.8%), the scientific literature (47.4%), and AAPD policies and guidelines (46.1%). However, for 3.5% of our respondents, our survey was the first time they had encountered ART.
**General conclusion**

Collectively, our results suggest that the use of ART is not widespread in the US. In addition, ART is viewed by some as a sub optimum treatment and needs to be modified to conform to the US standards of care. On the other hand, educators and pediatric dentists who believed in ART thought it could be a valuable treatment for very young, uncooperative children and children with no insurance.

In conclusion, ART could be an effective solution for children whom traditional care is not possible. ART should be taught in our educational institutions as a valid restorative treatment option among others; the good scientific evidence of ART and its place in modern concepts of minimal invasive dentistry should be emphasized.
APPENDIX:

Appendix I: Survey instrument used in Study II*

*Caries Management Techniques in Pediatric Dentistry Programs

In this survey we would like to ask you some questions about your predoctoral Pediatric Dentistry program.

Before asking about the didactic and clinical instruction the predoctoral Pediatric Dentistry program provides to the dental students, we would like to collect information about you as the program director, chair or coordinator.

1) What is your gender?
   - Female    - Male

2) What is your age?

   _YEARS_

3) What year did you graduate from dental school?

   [Format: 9999]

4) From where did you receive your dental degree?
   - US Dental school
   - Non-US dental school
   - I have dental degrees from both a US dental school and a non-US dental school

5) Which of the following best describes where you did your advanced training in Pediatric Dentistry?
   - Dental school-based training
   - Hospital-based training
   - Public or Community health centers-based

6) Are you board certified in Pediatric Dentistry?

*The survey that was used in study I is very similar to this one, therefore, we will present only one version of the survey, Study II survey.
7) Do you have any other post DDS-DMD specialty training or academic degrees other than Pediatric Dentistry? Please check all that apply:

☐ No other specialty, formal clinical training or academic degrees
☐ Dental Public Health/MPH
☐ General practice Residency(GPR) or Advanced Education in General Dentistry (AEGD)
☐ PhD
☐ Other (please specify)

If you selected other, please specify:

8) Before becoming program director, chair, or coordinator, please indicate the number of years you spent in each of the following settings:

Private practice _______ years
Academics (Full time faculty) _______ years
Public Health Service _______ years
Military dental corps _______ years
Other, please specify: ____________________________ years

9) During the past twelve months, please estimate the percentage of time per week spent in each of the following:

Research _______ hrs/wk
Administration _______ hrs/wk
Direct patient care _______ hrs/wk
Teaching/ student supervision _______ hrs/wk
Other, please specify: ____________________________ hrs/wk

10) When you discuss restorative treatment options with your dental students, please indicate the level of importance for each of the following factors:
11) Please indicate the influence of the following sources on your knowledge regarding different restorative options.

<table>
<thead>
<tr>
<th></th>
<th>Very influential</th>
<th>Influential</th>
<th>Neither influential nor not influential</th>
<th>Not influential</th>
<th>Not influential at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colleagues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuing education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Journal articles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advertisements or sales reps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-doctoral training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Now, we would like to collect some information about the pre-doctoral Pediatric Dentistry program you direct, chair, or coordinate:

12) How would you describe the area in which your program’s main facility is located?
   - Urban area – Inner city
   - Urban area, but not located in the inner city
   - Urban area, suburb
13) Do dental students in your program provide oral care for children 3 years or younger?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventive care and diet counseling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restorative care</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14) Please indicate how often the dental students use each of the following behavioral management techniques when they provide extensive restorative treatment for children 0-3 years of age.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Very Often</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non pharmacological behavior management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protective stabilization (Medical immobilization, papoose board)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Anesthesia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15) Please indicate how often the dental students use the following techniques when they provide extensive restorative treatment for children older than 3 years.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Very Often</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-pharmacological behavior management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protective stabilization (Medical immobilization, papoose board)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrous oxide</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Anesthesia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
16) Does your program perform a caries risk assessment with each new patient?
   ○ Yes
   ○ No

17) Considering the overall clinical training experience of your dental students, please estimate the percentage of their time spent in each of the following settings?

   On-site dental school facilities  %
   Affiliated hospital-based dental clinics  %
   Off-site, satellite or affiliated dental clinics  %
   Off-site, Public Health clinics  %
   Off-site, migrant worker camps  %
   Off-site, international programs  %

The following questions are about the patient population that is treated in your program. For these questions, please consider the experience of the average dental student:

18) Please estimate the percentage of Pediatric Dentistry patients seen by the dental students that are covered by each of the following payment sources?

   Medicaid and other public insurance e.g. S-CHIP  %
   Private insurance  %
   Without insurance (out of pocket)  %
   Other  %

19) Approximately what percentage of the patients seen by the dental students are at high caries risk (multiple current or recent past carious lesions)?

   %

20) Approximately what percentage of the patients seen by the dental students are at low caries risk (no current or recent active carious lesions)?

   %

21) Approximately, what percentage of your residents’ patient population is in each of the following age groups?
Younger than 3 years %
3-5 years %
6-12 years %
13 and older %

22) Do your students routinely treat patients with special health care needs?

☐ Yes
☐ No

For the following questions, we would like to collect information about treatment options used in your program:

23) How often do the dental students typically place fissure sealants in the following situations?

<table>
<thead>
<tr>
<th>Situation</th>
<th>Very often</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound fissures in permanent teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incipient carious fissures in permanent teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound fissures in primary teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incipient carious fissures in primary teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

24)

When restoring carious teeth, how often do the dental students perform the following procedures?

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Very often</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placing amalgam in primary teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placing amalgam in permanent teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using facial or proximal slot approach in primary or permanent teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using tunnel approach in primary or permanent teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using the G.V. Black &quot;extension for prevention&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 25)

**When restoring carious teeth, how often do the dental students perform the following procedures?**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Very often</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Placing glass-ionomer restorations in anterior primary teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placing glass-ionomer restorations in anterior permanent teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placing glass-ionomer restorations in posterior primary teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placing glass-ionomer restorations in posterior permanent teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placing composite-based restorations in anterior primary teeth.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placing composite-based restorations in anterior permanent teeth.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placing composite-based restorations in posterior primary teeth.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placing composite-based restorations in posterior permanent teeth.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 26) Please indicate how often the following types of Glass Ionomers are used by the dental students in your Pediatric Dentistry clinics.

<table>
<thead>
<tr>
<th>Type of Glass Ionomer</th>
<th>Very often</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Glass Ionomer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resin modified Glass Ionomer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polyacid modified resins &quot;compomers&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 27) Does your program provide hands-on instruction on placement of stainless steel crowns?

- Yes
- No
28) If yes, please indicate whether or not you use the following instruction format to train the dental students how to place stainless steel crowns:

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory hands-on</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical hands-on</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

29) Does your program provide instruction on crowning vital, decayed asymptomatic primary molars without preparation (Hall technique)?

- Yes
- No

30) Does your program’s didactic instruction teach that preparing cavities using only hand excavators can be a proper technique in certain situations?

- Yes
- No

31) How often do the dental students prepare cavities using only a hand excavator in the following situations?

<table>
<thead>
<tr>
<th></th>
<th>Very often</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary anterior teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent anterior teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary posterior teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent posterior teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

32) In situations where the dental students use "hand instrumentation only" to remove caries and prepare a cavity, how often are the following restorative materials used?

<table>
<thead>
<tr>
<th></th>
<th>Very often</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amalgam in posterior teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composite-based restorations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In the following questions, we would like to collect some information about your attitude towards certain concepts in Pediatric Dentistry:

33) To what extent do you agree or disagree with the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Somewhat Agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Using fluoride varnish as a remineralization agent can reverse some incipient smooth surface carious lesions</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b. A &quot;No treatment&quot; option should not be used in planning treatment for children with carious lesions except for teeth about to exfoliate.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c. Definitive restorations should be the treatment of choice regardless of other factors</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d. A formal caries risk assessment should be carried out periodically and thoroughly for all children in the pediatric dental office</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>e. Fluoride varnish should be applied at recall exams regardless of a child’s caries risk</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>f. Placing fissure sealant on fissures with incipient lesions in permanent molars is a valid practice</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>g. Leaving caries in the floor of a prepared cavity is never justified.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
155

<table>
<thead>
<tr>
<th>h. Excavating caries with a hand excavator and placing an adhesive mateethrial can be a valid treatment option in certain situations</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>

For the purposes of the following questions, please consider Atraumatic Restorative Treatment (ART) to be "a procedure based on removing carious tooth tissues using hand instruments alone and restoring the cavity with an adhesive restorative mateethrial."

34) To what extent do you agree or disagree with the following statements:

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ART can be used as a caries stabilization method</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. ART can not be considered as a definitive treatment under any circumstances</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. ART could help in addressing problems related to access to oral care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. ART does not meet the standard of care in the US</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. ART can be a good option for high caries risk children with multiple cavities carious lesions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. ART is not suitable for use in children with special health care needs (IDD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. ART can be effective in treating very young children</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. ART can be a valid treatment option for children with limited financial resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. ART should be modified to conform with the oral health care standards in the US</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
35) Does your program provide any didactic instruction on ART, as defined above, in your curriculum?

○ Yes
○ No

36) If yes, please indicate whether or not you use the following formats to provide didactic instruction on ART.

<table>
<thead>
<tr>
<th>Format</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic or paper handouts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small group discussions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case-based learning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Video presentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assigned readings</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

37) Does your program provide clinical instruction on ART, as defined above?

○ Yes
○ No

38) How often do the dental students use ART, as defined above, as a caries management technique for their pediatric dentistry patients?

○ Very often ○ Often ○ Sometimes ○ Rarely ○ Never

39) What types of ART restorations, as defined above, do the dental students provide to their patients?

<table>
<thead>
<tr>
<th>Type</th>
<th>Very often</th>
<th>Often</th>
<th>Sometimes</th>
<th>Rarely</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>ART in anterior teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ART in posterior teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ART in single-surface cavities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ART in multi-surface cavities

ART as an interethrim treatment in primary teeth

ART as an interethrim treatment in permanent teeth

ART as a definitive treatment in primary teeth

ART as a definitive treatment in permanent teeth

40) If No, why do you think your program does not provide instruction on ART? (Check all that apply)

☐ No space in the curriculum
☐ No special ADA code exist to reimburse ART restorations
☐ Students should learn ideal restorations first
☐ It is too advanced for my students
☐ ART is a sub optimum treatment
☐ Insufficient scientific evidence that support the use of ART
☐ Other (please specify)

If you selected other, please specify:

41) Do you have any other comments you’d like to make?

Thank you for completing this questionnaire!
Appendix II: Survey instrument used in Study III

The use of alternative caries management techniques among pediatric dentists

Definitions of some nomenclature used in this Survey:

I. ART in this survey stands for Atraumatic Restorative Treatment and it is defined as:

"A procedure based on removing carious tooth tissues using hand instruments alone and restoring the cavity with an adhesive restorative material". The American Academy of Pediatric Dentistry refers to this procedure as ITR, Interim Therapeutic Restoration.

II. For child’s behavior, we assigned:

"Uncooperative" for Frankl’s class 1
"Shows moderate cooperation" for Frankl’s class 2
"Cooperative" for Frankl’s classes 3 and 4

Frankl Behavior Rating Scale:

Class 1: child is completely uncooperative, crying, and very difficult to make any progress
Class 2: child is uncooperative, very reluctant to listen/respond to questions, some progress is possible
Class 3: child is cooperative, but somewhat reluctant/ shy
Class 4: child is completely cooperative and even enjoys the experience

In the following clinical scenarios, we will present different situations that include children with different ages, level of cooperation and insurance coverage; however for the next nine hypothetical scenarios assume that:

1. The carious lesion is in an upper anterior primary tooth
2. The carious lesion is deep into the dentin but with no pulp involvement evident clinically or radiographically.
How likely are you to use ART in the following situations?

<table>
<thead>
<tr>
<th>Situation</th>
<th>Very likely to use ART</th>
<th>Somewhat likely to use ART</th>
<th>Neither unlikely nor likely to use ART</th>
<th>Somewhat unlikely to use ART</th>
<th>Very unlikely to use ART</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 4 year old child who shows moderate cooperation and doesn't have any dental insurance coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A 6 year old child who is uncooperative and doesn't have any dental insurance coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A 2 year old child who shows moderate cooperation and has private dental insurance coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A 2 year old child who is uncooperative and has public dental insurance coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A 4 year old child who is uncooperative and has private dental insurance coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A 6 year old child who shows moderate cooperation and has public insurance coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A 2 year old child who is cooperative and doesn't have any dental insurance coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A 6 year old child who is cooperative and has private dental insurance coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A 4 year old child who is cooperative and has public dental insurance coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


In the previous scenarios did you consider ART restorations as a definitive or interim treatment?

☐ Most of the time I considered ART as interim treatment
☐ Most of the time I considered ART as definitive treatment

What factors make you decide to use ART as definitive or interim treatment in primary teeth? (Check all that apply)

☐ Caries risk of the patient
☐ Number of cavities present in child’s mouth
☐ Insurance coverage of patient
☐ Depth of lesion
☐ Age of child
☐ Cooperation of child
☐ Number of surfaces involved (single or multiple)
☐ Location of the tooth (anterior or posterior)
☐ Tooth surface involved (smooth or fissure)

How did you learn about ART technique? (check all that apply)

☐ Dental education
☐ Advanced pediatric training
☐ Continuing education
☐ Scientific literature
☐ AAPD policies and guidelines
☐ Colleagues
☐ Other
☐ This is the first time I heard about it
Now we have few questions about you, your practice and the patient population you serve:

Location of current practice:
- Urban area – Inner city
- Urban area, but not located in the inner city
- Urban area, suburb
- Small city
- Rural or small town

Total years in practice:
- <5 years
- 6-10 years
- 11-15 years
- 16-20 years
- 21-25 years
- 26-30 years
- >30 years

Nature of primary practice:
- Private
- Hospital-based
- Academic institution
- Military service
- Public health service
- Academic intramural
- Community / public health clinic
- Other:

Pediatric dentistry board certification status
- Not board certified
- Board certified
- Board certified + other specialty board
Type of certificate program attended:
- University based
- Hospital based
- Combined program (University and hospital based)

Which of the following best describe your primary practice in the last year?
- Too busy to treat all people requesting appointments
- Provide care to all who requested appointment but was overworked
- Provided care to all who requested appointment but was not overworked
- Not busy enough, could have treated more patients

Approximately what percentage of all patients who visited your primary practice last year were:
- Younger than 3 years old [ ] %
- 3-6 years old [ ] %
- 7-12 years old [ ] %
- Older than 12 years old [ ] %

Approximately what percentage of all patients who visited your primary practice in the last year were:
- Covered by a public assistance program that pays or partially pays for their dental care [ ] %
- Covered by a private insurance program that pays or partially pays for their dental care [ ] %
- Not covered by any insurance program [ ] %

Approximately what percentage of the children patients seen in your primary practice are at high caries risk (multiple current or recent past carious lesions)? [ ] %

Thank you for your time
REFERENCES


13. CDC. Healthy people 2010, progress review, focus area 21, oral health presentation. 2010.


20. Taifour D, Frencken JE, Beiruti N, {van ‘t Hof} MA, Truin GJ. Effectiveness of glass-ionomer (ART) and amalgam restorations in the deciduous dentition: Results after 3 years. Caries Res. 2002;36(6):437-44.


154. SPSS Inc. PASW STATISTICS 18.0. 2010.


226. SPSS help topics, conjoint command, simulation, PASW statistics 18, release version 18.0.0 [Internet]. Available from: www.spss.com.


