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Children with Autism Spectrum Disorder are able to Maintain Dental Skills: A 2-year follow-up of Desensitization Treatment

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Abstract

Children with Autism Spectrum Disorder are able to Maintain Dental Skills: A 2-year follow-up of Desensitization Treatment

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Purpose: The purpose of this study was to determine: (1) how ability to receive a Minimum Threshold Exam (MTE) was maintained, (2) what new dental skills were acquired, and (3) the prevalence of GA, oral sedation, and protective stabilization used.

Methods: We organized a retrospective 2-year case series. The sample was comprised of 138 children with ASD who participated in a dental desensitization program. Data were obtained from chart notes for each subject and a comprehensive pre-visit information intake form completed by the caregiver.

Results: The results show that once the MTE had been achieved, the majority of children (92%) maintained the skill. Some new dental skills were attained by most children, most commonly toothbrush prophylaxis (83%) and fluoride varnish (77%). However, most other skills (rubber-cup prophylaxis, radiographs, hand scaling, sealants or restorative care) the majority of children never accomplished. Use of oral sedation and protective stabilization was minute, but 22% of children needed General Anesthesia for dental care.

Conclusions: The results of this study suggest that most children with ASD who learn to receive an oral examination will maintain that ability over time. Teaching children with ASD to cooperate for an exam allows long-term oral health supervision and diagnosis of dental disease at an early stage when it can be more easily addressed. In contrast to the high rate of exam maintenance, children in the study did not acquire new dental skills at nearly the same rates. Therefore, as patients with ASD age it is important to consider that some will require ABGT.

TABLE OF CONTENTS

Background……………………………………………………………………………………1

Methods…………………………………………………………………………………..…...3

Study Design and Sample……………………………………………………..…………3

Variables………………………………………………………………………………3

Collection and Analysis of Data………………………………………...........………4

Results…………………………………………………………………………………………7

Sample Characteristics…………………………………………..…………………7

Ability to Receive Minimum Threshold Exam During the Study Period…………..……9

New Dental Skills Achieved………………………………………………………...9

Discussion…………………………………………………………………………..……10

Ability to Receive a MTE…………………………………………………..………10

Additional Dental Procedures Performed……………………………………..…………12

Advanced Behavior Guidance……………………………………………...………14

Limitations and Future Research…………………………………………………..…15

Conclusion………………………………………………………………..…………..……16

Tables..………………………………………………………………………………..….17

Figures..……………………………………………………………………………….……22

References..………………………………………………………………………..….23

LIST OF FIGURES

Figure 1: Percentage of Children That Performed Additional Dental Skills……………………22

LIST OF TABLES

Table 1: Association of Demographic and Treatment Variables for Children with ASD and Their Ability to Receive MTE at the End of the Study Period………………………..……17

Table 2: Association of Behavioral Variables for Children with ASD and Their Ability to Receive MTE at the End of the Study Period……………………………………………19

Table 3: Association of Clinic Visits Over Study Period and MTE Maintenance………...20

Table 4: Additional Dental Skills Obtained During Study Period and Associated Descriptive Characteristics…………………………………………………………….........……21

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DEDICATION

I dedicate this work to my wife. Her care for and work with the Autism community gave me the desire to learn more. She is creative, passionate in everything she does, and genuine in her interactions. I am lucky to have her as my steadfast partner, loving wife and best friend.

Thank you Jessie. I love you.

Quinn

BACKGROUND

Autism Spectrum Disorder (ASD) is a lifelong developmental disability that affects one out of sixty-eight children. [1] Individuals with ASD have deficits in social interaction, communication and restrictive, repetitive patterns of behavior. [2] These aspects of ASD can make dental appointments unpredictable. Consequently the unmet dental need in the ASD community is 12-15%, compared to 5% for typically developing children. [3] Basic Behavior Guidance Techniques such as tell-show-do, positive reinforcement, and distraction are frequently ineffective for children with ASD. [2,4,5] The challenging behavior of children with ASD often results in use of advanced behavior guidance techniques (ABGT: protective stabilization, oral sedation and general anesthesia) to provide dental care. [4-6]

In recent years several behavior management techniques from the educational setting have been adapted for dental care. [2,6,7] The goal of these methods is to help children with ASD learn the skills necessary to receive oral care. Treatment protocols that have been employed include: visual preparation aids, [8-12] applied behavior analysis (ABA), [2] developmental individual differences (DIR), relationship based approach, [13] treatment and education of autistic and related communication-handicapped children (TEACCH), [14] individualized reinforcement, [11,15] sensory adapted dental environments (SADE), [16] and progressive desensitization with individualized reinforcement. [3]

Many children with ASD can learn to accept dental examination through implementation of dental-oriented protocols that employ progressive desensitization with individualized reinforcement. [17] Patients are gradually exposed to aspects of a dental appointment while

progression and rewards are individually based. This allows patients to become accustomed to the dental exam experience at a pace that facilitates acceptance of care. In a population of 168 children with ASD, dental desensitization resulted in an 87.5% of children successfully receiving minimum threshold exams (MTE, an examination with an intraoral mirror while seated in a dental chair). [17] Several characteristics predicted which children had successful dental exams: ability to be involved in group activities, ability to communicate verbally, understanding of most language, and moderate versus severe caregiver-rated ASD severity. Overall, children who had characteristics consistent with a milder presentation of ASD were more likely to be successful. [17] Dental desensitization provides an avenue for children with ASD to receive their first successful MTE, however it is not understood if the ability to receive dental exams is maintained over time. This study investigated treatment provided to a cohort of children with ASD during the two-years following each child's initial MTE.

We hypothesized that children who are young, carry a co-morbid medical diagnosis, have parent-rated severe autism, are non-verbal, and have limited self-care abilities will be less likely to maintain the ability to receive dental examination over time. The specific aims of this study were to determine among patients who successfully obtained an initial MTE: (1) to what degree the ability to receive a MTE was maintained, (2) what new dental skills were acquired by members of the cohort, and (3) the prevalence of GA, oral sedation, and protective stabilization use in the study population.

METHODS

Study Design and Sample:

We conducted a retrospective case series. The sample was comprised of 138 children who participated in a dental desensitization program for children with ASD at the University of Washington's Center for Pediatric Dentistry between January 2012 and January 2017. Criteria for inclusion were (a) ASD diagnosis by a physician; (b) age 4-21 years old; (c) completed a pre-visit questionnaire (d) successful completion of initial MTE, defined as an examination with an intraoral mirror while seated in a dental chair (e) continued attending dental appointments at the study clinic during a 2-year period following the initial MTE. Subjects in the pre-cooperative age group (0-3 years old), those with incomplete chart entries or pre-visit intake forms, patients with non-English speaking caregivers who were unable to complete the intake form, accounts frozen due to unclaimed funds, and patients who did not attend dental visits at the study clinic within the 2 year period following the initial MTE were excluded from the study.

Data were obtained from chart notes for each subject and a comprehensive pre-visit information intake form that was completed by the caregiver. The form asked about prior treatment experiences, behavior, social and communication skills. This study was approved for human subjects by the University of Washington Institutional Review Board (HSD #49134).

Variables

Predictors. The primary independent variables of interest were classified as treatment variables and behavioral variables. Treatment variables included history of therapy (any therapy, speech, occupational, complementary and alternative medicine, behavioral and physical) and number of

therapies received. Behavioral variables included caregiver-rated ASD severity, level of challenging behaviors, social abilities (cooperate during simple activities, be involved in group activities, engage in shared activities, play with friends, and have friends), communication skills (verbal, understand language, follow one-step directions, mimic, communicate with written words, and use sign language), and self-care skills (dress by self, use toilet by self, bathe by self, brush own teeth, and brush own hair).

Outcomes. The primary outcome variable of interest in this study was the subject's ability to receive a MTE at each subsequent visit to the clinic after the initial MTE was achieved. The secondary variable of interest was additional diagnostic, preventive, or restorative dental procedures achieved following the MTE.

Other variables. Other variables of interest included age, gender, race, insurance status, comorbid medical conditions, history of therapy, caregiver-rated ASD severity, social abilities, communication skills, and self-care skills. Use of GA, oral sedation, and protective stabilization was collected to ascertain the prevalence of ABGT use in the study population. Differences in dental procedures performed during year one and two of the study period were compared.

Collection and analyses of data

Baseline Caregiver Questionnaire

Per clinic protocol, prior to the initial clinical visit and administration of the desensitization protocol, a 34-item questionnaire was mailed to the family and returned to the clinic. A five-

point Likert scale was used to assess the child's behavioral characteristics, self-care abilities, and communication skills. A description of the study instrument is provided elsewhere. [17]

Baseline Clinical Procedures

All participants were initially treated by a single University of Washington (UW) pediatric dentistry attending faculty member or by UW pediatric dentistry residents under the supervision of the same faculty member. Beginning with the first desensitization visit, behavior for several aspects of the appointment (enter room, sit in dental chair, mirror examination, etc.) was rated on a Likert scale (1-completely unable, 5–able without difficulty) by the dentist who performed the care. Providers were trained to record detailed behavioral information in the electronic chart. If the numerical Likert scale data was missing, the note was reviewed by two independent raters who reached consensus on the behavioral score based on the written behavioral description and the treatment completed.

Numerical behavior scores for each visit were extrapolated to the Frankl behavior scale, a behavior rating system which separates patient behaviors into four categories ranging from definitely positive to definitely negative.[29] A positive (+) or definitely positive (+/+) Frankl score was considered "cooperative." Frankl negative (-) or definitely negative (-/-) was considered "uncooperative." Behavior was coded as uncooperative if the treatment goal was not achieved through voluntary cooperation or if protective stabilization was used to achieve the treatment goal.

MTE was considered to have been achieved for each visit where the child had a behavioral score of 3 (able with moderate difficulty) or greater for: 1) sitting in a dental chair and 2) receiving a dental examination with a mouth mirror. Details of the study clinic protocols are described in the initial study publication. [17]

Follow-up - Outcome Measures

After the MTE was attained, follow-up care was provided in the same institution, but continuity of resident and attending dentist was not always possible. The same clinical procedures and behavioral ratings that were completed at baseline were performed at each follow-up visit.

Follow-up Chart Abstraction

In addition to the information collected at baseline, for each follow-up visit after the initial MTE, we conducted a detailed chart abstraction to determine: (1) The child's ability to accept a MTE (yes/no) (2) The child's ability to complete any additional diagnostic, preventive, or restorative dental procedures with a score of 3 or greater on the Likert scale or a + or greater using the Frankl behavior scale (toothbrush prophylaxis, rubber cup prophylaxis, dental scaling, fluoride varnish application, panoramic radiograph, intraoral radiographs, sealants, other preventive care, and restorative dental treatment) (3) Use of GA, oral sedation, and protective stabilization (4) the total number of visits to the study clinic after achieving a MTE (5) whether each child was able to receive a MTE at the final visit in the two-year period following the initial MTE.

Statistical Analysis

Frequencies and percentages were calculated for categorical variables including: demographics, language, insurance, caregiver-rated ASD severity, history of behavior guidance, behavioral, communication, self-care, and mood characteristics as well as co-occurring medical conditions. We estimated unadjusted relative risks (RR) and generated p-values using a modified Poisson regression model with robust standard errors to quantify the association between predictors of interest and ability to receive follow-up MTE. Overall p-values were obtained using Fisher's exact test and Wald test.

RESULTS

Sample Characteristics

A total of 138 children with ASD completed an initial MTE and were eligible for inclusion during the 24-month follow up study period. Of these 138 children, 127 (92%) maintained the ability to receive MTE at their two-year follow up. The male to female ratio was 4.75:1. Subjects were grouped according to age: 4-6 (40%), 7-12 (43%) and 13-18 (17%). Half of the patients identified as Caucasian, and the other half was comprised of a diverse mix of Asian, Black/African American, and other races. Over half of the subjects (55%) had public insurance, while 43% had private insurance and 2% had no insurance. Nearly all of the subjects lived with their parents (95%). The most common co-morbid medical conditions were: sensory sensitivities (49%), anxiety (33%), sleep disorder (22%), gastro-intestinal problems (17%) and seizures (7%). Most subjects in our study (80%) received some form of behavioral or medical therapy. The most frequently reported were speech (74%) and occupational therapy (59%). Nearly half the subjects (47%) participated in behavioral therapy. Of the five types of therapies measured, one quarter of subjects received 0-1, over half (53%) received 2-3 and 13% received 4-5 (Table 1).

There were no statistically significant associations between patient characteristics and ability to maintain a MTE during the study period. During the course of the study period, one quarter of subjects required Advanced Behavior Guidance Techniques (ABGT). This consisted almost exclusively of restorative dental treatment under general anesthesia (22%). Very few subjects received Protective Stabilization (2%) or Sedation (1%). There was no association between a subject's ability to continue receiving exams and treatment under GA.

Caregiver rating of ASD severity ranged from 23% of children described as mild, 42% as moderate and 19% as severe (Table 2). Half the subjects had low levels of challenging behaviors while the other half had either moderate (41%) or high levels (7%). Most subjects had some form of social skills, which included: 89% had the ability to cooperate during simple activities and engage in shared activities, two-thirds were able to play with others and be involved with group activities, and 38% were reported to have friends. The communication skills of participants varied; 70% of children could follow one-step directions and approximately half were verbal or could understand language. Very few children could communicate with written words (11%) or use sign language (3%). The self-care skills of most subjects were good. Over 80% could dress and use the toilet on their own and around 60% could bathe, brush their teeth, or brush their hair by themselves. None of these behavioral variables were significantly associated with subjects maintaining the ability to receive a MTE during the study period (Table 2).

Ability to Receive Minimum Threshold Exam During the Study Period

All subjects had achieved a MTE at baseline to be eligible for inclusion. The majority (80%) maintained this dental skill throughout the 24-month study period (Table 3). Twelve percent of

participants failed to accept a MTE at some point during the course of the study, but regained the ability by the end of the study period. Approximately 60% of children who failed MTE regained the ability during the study period. Over half of the children who failed and regained the ability to receive a MTE had in excess of 8 clinic visits over the two-year period. Most patients (66%) who maintained the MTE exam had 3-6 appointments during the study period. This corresponds with a 4-6 month recall interval. Eight percent failed to accept a MTE during the study period and never regained the skill (Table 3).

New Dental Skills Achieved

In addition to maintenance of MTE, we measured new dental skills that were obtained during the course of the study period. The most common skill was toothbrush prophylaxis, with the majority of the population (83%) receiving that service. Many subjects (77%) were able to receive fluoride varnish, and nearly half had rubber cup prophylaxis. Approximately 4 in 10 patients received intraoral radiographs or hand scaling. About 1 in 5 received a panoramic radiograph. Sealants (17%) and restorative care (16%) were provided to the lowest number of patients (Figure1). We analyzed the difference in new dental skill accomplishment between study years one and two. There were no significant differences and no trends between years one and two (data not shown).

To understand the relationship between dental skills performed and subject characteristics we compared three important procedures. Fluoride application, rubber cup prophylaxis and intraoral radiographs were analyzed by subject age, caregiver-rated ASD severity and number of clinic visits (Table 5). Age and severity were statistically associated with a child's ability to take

intraoral radiographs. Approximately one quarter of children 4-6 were able to achieve intraoral radiographs, but 65% of teenagers accomplished the skill. Children with greater ASD severity were about half as likely to achieve radiographs as their mildly affected peers. The total number and frequency of visits to the clinic was associated with skill attainment. Those who were seen 3-6 times during the study period (a typical 4-6 month recall interval) had the greatest frequency of success for fluoride varnish application and rubber cup prophylaxis (Table 5).

DISCUSSION

In this study we evaluated a sample of children with ASD who received care in a university based dental clinic. The purpose was to evaluate whether subjects were able to maintain the ability to receive a MTE, determine additional dental skills obtained by the study population, and understand the use of ABGT in the population over a two-year period.

Ability to Receive a MTE

The results of this study show that once the MTE had been achieved, the overwhelming majority of children maintained the skill over the 2-year study period. It is important to note that this was observed in a very heterogeneous population that included a wide variety of ages, comorbid conditions, and ASD severity. Patients also received treatment from a number of care providers. Consistency is important for many patients with autism, and the fact that this result was achieved with a diverse care team is encouraging. We did not identify any specific characteristics that were associated with a patient's ability to receive examination over the study period. This may be due to the small number of patients who were unable to maintain the MTE. Previous research[17] illustrated that 87.5% of children with ASD learned to receive an MTE. This study

adds to those findings, indicating that once the exam skill is attained it can be maintained for at least two years.

A small portion of the study population (12%) failed MTE but regained the ability to receive a dental examination at some point during the study period. Of these children, over half had 8 or more visits during the two year follow-up. This likely indicates a concerted effort on the part of the families and the clinic to regain learned dental skills. The results suggest that behavioral progress can be variable. Some patients may experience a "one step forward, two steps back" phenomenon. For these types of children, it appears that redoubling behavior modification efforts may be beneficial.

Previous research indicates that factors such as ASD severity, age, gender, and levels of challenging behaviors can be associated with patient cooperation.[17] Dangulavanich et.al. found that verbal skills were associated with cooperation: 77% of children with no verbal skills were uncooperative and 63% who used sentences were cooperative. They showed that 85% of those who were not toilet trained were uncooperative.[18] In contrast, in our study there was not statistically significant association between ASD severity, challenging behaviors, age, sex, race, or any other factors and the ability to maintain a MTE. We did notice a trend suggesting that patients with severe ASD may be less likely to maintain MTE, however this finding was not statistically significant. These results may be partially explained by the study sample. To be eligible for inclusion all subjects must have already achieved a MTE. This indicates that many of the patients likely had a relatively high baseline level of cooperation. We may have also been

underpowered to detect differences given the homogeneity in a group that has already demonstrated the ability to achieve the outcome of interest.

Additional Dental Procedures Performed

Nearly all children were able to gain additional dental skills during the study, yet it is important to recognize that less than half received preventive services considered to be standard of care in pediatric dentistry (rubber cup prophylaxis and radiographs). Simple procedures such as toothbrush prophylaxis and fluoride varnish were the most common accomplishments. A small-scale study previously reported the abilities of children with ASD to perform certain dental tasks.[8] Their small sample revealed trends that were similar to our study. The majority of participants allowed an examination with a mirror while in the dental chair, placement of fluoride, and dental prophylaxis. Patients enrolled in that study had much more difficulty with operative dental procedures.

We noted statistically significant associations between dental skills attained and age, caregiver-rated ASD severity and number of clinic visits. Typically developing children generally learn more and more dental skills as their age increases. Similarly, this study found that older children with ASD were more likely than younger peers to allow intraoral radiographs. Children with milder ASD also received rubber cup prophylaxis and intraoral radiographs more frequently. Those who were seen most frequently showed the greatest level of accomplishment.

It is important to note that dental procedures beyond the MTE were attempted at the discretion of the dental providers. Therefore, while the frequency of procedures such as intraoral radiographs

was not high it does not necessarily mean that the patient attempted and failed this skill. The dental provider may have made the determination that the procedure was not necessary (e.g. sealants were not warranted) or that the child was unlikely to comply with that procedure. Practitioners should consider that while many children can learn to receive a basic oral examination, the ability to achieve other preventive skills is much more variable. For this reason, when caring for this population it is important to have access to ABGT such as procedural sedation and GA.

We found that receiving fluoride application, rubber cup prophylaxis and intraoral radiographs was significantly associated with age, autism severity and frequency of clinic recall. Patients in their teen years were able to take radiographs at much higher rates than younger participants. While this is frequently observed in typically developing children, we showed in this study that by the teen years approximately 2/3 of our population was capable of receiving diagnostic intraoral radiographs. This correlates with a recent study's findings that increasing age led to higher levels of cooperation in children with ASD. They found that children 11-18 years were 11 times more likely to cooperate for dental examinations than their younger counterparts. [18] It is also important to note that the most severely affected patients were the least likely to be able to receive intraoral radiographs. This has important implications for planning treatment and setting parent expectations. It may not be realistic for young children and those with severe ASD to receive intraoral radiographs. Therefore, high caries risk patients in this segment of the population may benefit from more frequent clinical surveillance or radiographs under sedation/GA at routine intervals.

The total number of clinic visits was associated with ability to receive dental treatment. Children receiving preventive care at routine 4-6 month intervals were most likely to successfully receive fluoride varnish, rubber cup prophylaxis, and intraoral radiographs. This finding is likely due to the fact that children who were able to receive standard preventive treatments were generally only seen at periodic intervals. Those who visited more frequently may have done so in an attempt to achieve those skills, while those who came less frequently may have experienced less success as a result of having fewer opportunities to practice. It is also important to consider that in some situations a specific recall frequency may have been prescribed, but parents adherence to that protocol could affect the actual frequency of visits.

The difference in dental procedures performed during study period year one and two was assessed. We had expected to see a higher rate of procedures accomplished during year two, as participants would have had more opportunities to practice. However, there were no major differences between the two years. A two-year period may have been too short to appreciate the long-term positive effects of a desensitization program.

Advanced Behavior Guidance

Advanced behavior guidance techniques (ABGT) are frequently utilized for treatment of children with Autism. Recognizing the behavioral challenges that many of these children present, parents of children with ASD have a higher acceptance of ABGT than those of typically developing peers. [5] In our population, 22% received treatment under GA during the study period. Others have also reported a high prevalence (37%) of GA for children with ASD. [6] The fact that many children, 1 in 5, received services under GA is important. In our study this was likely the result

of a clinical philosophy of caring for children in a way that preserves long-term cooperation. This is reflected not only in the high rate of GA utilization, but also in the small number of children who received restorative treatment in the clinic setting. This reflects what has been found in a recent study where use of GA for children with ASD was not associated with behavior. [18] The study showed that the majority of children were cooperative for preventative procedures (63%), but uncooperative for operative without local anesthetic (LA) (83%) or with LA (72%).[18] This is similar to our finding that many children tolerate exams, but success with more invasive procedures is more variable.

While dental sedation for children with ASD has been well documented in the literature, [19-21] this study saw a very limited use of oral sedation (1%). Sedation of patients with ASD can be highly unpredictable for both medication and behavior response.[22] The availability and predictability of GA at the study location likely influenced providers to provide invasive procedures in that manner. There was also limited use of protective stabilization. This was likely because, like other desensitization studies,[7,13,15,17] the goal of the program was to build upon positive dental experiences.

Limitations and Future Research

This study was limited by its retrospective observational design. Randomized controlled trials and studies with comparison groups are needed to provide more accurate and detailed information about the characteristics and abilities of children with ASD. All patients in this study lived at home (not in an institution), and over half had public insurance. These characteristics may limit the generalizability of the study. The demographic variables and patient characteristics

came from a caregiver survey so our data was limited by the completeness and accuracy of caregiver responses.

CONCLUSION

The results of this study suggest that most children with ASD who learn to receive an oral examination will maintain that ability over time. While this skill is very basic, it is critical for long-term oral health maintenance. Patients who are resistant to examination present major challenges for community dental providers and may be less likely to receive needed services. Teaching children with ASD to cooperate for an exam allows long-term oral health supervision and diagnosis of dental disease at an early stage when it can be more easily addressed. In contrast to the high rate of exam maintenance, children in the study acquired new dental skills at a highly variable rate. Therefore, when treating patients with ASD, even though new skills can be gained through desensitization, it is important to consider that some will require ABGT. Clinics who care for children and adults with special needs should be prepared for this, and public health resources should be allocated accordingly.

TABLES

Table 1. Association of Demographic and Treatment Variables for Children with ASD and Their Ability to Receive MTE at the End of the Study Period

Baseline Demographic	Total (N = 138) N (%)	Child Maintained MTE Skill at End of Study Period		Fisher's Exact Overall p-value
		Yes (N=127) N (%)	No (N=11) N (%)	
Age				
4-6 years	55 (40%)	50 (39%)	5 (45%)	0.92
7-12 years	60 (43%)	55 (43%)	5 (45%)	
13-18 years	23 (17%)	22 (17%)	1 (9%)	
Sex				
Male	114 (83%)	107 (84%)	7 (64%)	0.10
Female	24 (17%)	20 (16%)	4 (36%)	
Race				
Caucasian	69 (50%)	62 (49%)	7 (64%)	>0.99
Asian	15 (11%)	14 (11%)	1 (9%)	
Black/African American	13 (9%)	12 (9%)	1 (9%)	
Other/Multiple	24 (17%)	22 (17%)	2 (18%)	
Unanswered	17 (12%)	17 (13%)	0 (0%)	
Insurance				
Public	76 (55%)	71 (56%)	5 (45%)	0.61
Private	60 (43%)	54 (43%)	6 (55%)	
None	2 (1%)	2 (2%)	0 (0%)	
Lives With				
Parent(s)	131 (95%)	120 (94%)	11 (100%)	>0.99
Other	4 (3%)	4 (3%)	0 (0%)	
Unanswered	3 (2%)	3 (2%)	0 (0%)	
Baseline Co-Morbid Medical Condition Variables				
Sensory Sensitivities	67 (49%)	62 (49%)	5 (45%)	0.86
Anxiety	46 (33%)	45 (35%)	1 (9%)	0.18
Sleep Disorder	31 (22%)	30 (24%)	1 (9%)	0.32

Gastro-Intestinal Problems	24 (17%)	24 (19%)	0 (0%)	0.21
Seizures	9 (7%)	9 (7%)	0 (0%)	>0.99
Baseline History of Therapy Variables				
Any Therapy	110 (80%)	99 (78%)	11 (100%)	0.21
Speech Therapy	102 (74%)	92 (72%)	10 (91%)	>0.99
Occupational Therapy	81 (59%)	72 (57%)	9 (82%)	0.72
Complementary and Alternative Medicine	15 (11%)	15 (12%)	0 (0%)	0.35
Behavioral Therapy	65 (47%)	59 (46%)	6 (55%)	0.99
Physical Therapy	27 (20%)	26 (20%)	1 (9%)	0.68
Number of Types of Therapies Child Receives				
0-1	35 (25%)	33 (26%)	2 (18%)	0.27
2-3	73 (53%)	64 (50%)	9 (82%)	
4-5	18 (13%)	18 (14%)	0 (0%)	
Unknown	12 (9%)	12 (9%)	0 (0%)	
Use of Advance Behavior Guidance Techniques During Study Period				
Protective Stabilization	3 (2%)	3 (2%)	0 (0%)	>0.99
Sedation	2 (1%)	2 (2%)	0 (0%)	>0.99
General Anesthesia	30 (22%)	26 (20%)	4 (36%)	0.25

Table 2. Association of Behavioral Variables for Children with ASD and Their Ability to Receive MTE at the End of the Study Period

	Total (N = 138) N (%)	Child Maintained MTE Skill at End of Study Period		Fisher's Exact Overall p-value
		Yes (N=127) N (%)	No (N=11) N (%)	
Caregiver-rated ASD Severity				
Mild	32 (23%)	30 (24%)	2 (18%)	0.83
Moderate	58 (42%)	53 (42%)	5 (45%)	
Severe	26 (19%)	23 (18%)	3 (27%)	
Missing	22 (16%)	21 (17%)	1 (9%)	
Level of Challenging Behaviors				
Low	69 (50%)	63 (50%)	6 (55%)	>0.99
Moderate	57 (41%)	53 (42%)	4 (36%)	
High	10 (7%)	10 (8%)	0 (0%)	
Unknown	2 (1%)	1 (1%)	1 (9%)	
Social Abilities				
Cooperate during Simple Activities	123 (89%)	112 (88%)	11 (100%)	0.61
Be Involved in Group Activities	91 (66%)	86 (68%)	5 (45%)	0.18
Engage in Shared Activities	123 (89%)	113 (89%)	10 (91%)	>0.99
Play with Others	88 (64%)	82 (65%)	6 (55%)	0.53
Have Friends	52 (38%)	49 (39%)	3 (27%)	>0.99
Communication Skills				
Be Verbal	75 (54%)	71 (56%)	4 (36%)	0.50
Understand Language	66 (48%)	62 (49%)	4 (36%)	0.75
Follow One-step Directions	97 (70%)	88 (69%)	9 (82%)	0.73
Communicate with Written Words	15 (11%)	15 (12%)	0 (0%)	0.36
Use Sign Language	4 (3%)	3 (2%)	1 (9%)	0.30
Self-Care Skills				
Dress by Self	114 (83%)	105 (83%)	9 (82%)	>0.99
Use Toilet by Self	119 (86%)	110 (87%)	9 (82%)	0.55
Bathe by Self	89 (64%)	83 (65%)	6 (55%)	0.52
Brush Own Teeth	83 (60%)	78 (61%)	5 (45%)	0.34
Brush Own Hair	82 (59%)	76 (60%)	6 (55%)	0.75

Table 3. Association of Clinic Visits Over Study Period and MTE Maintenance

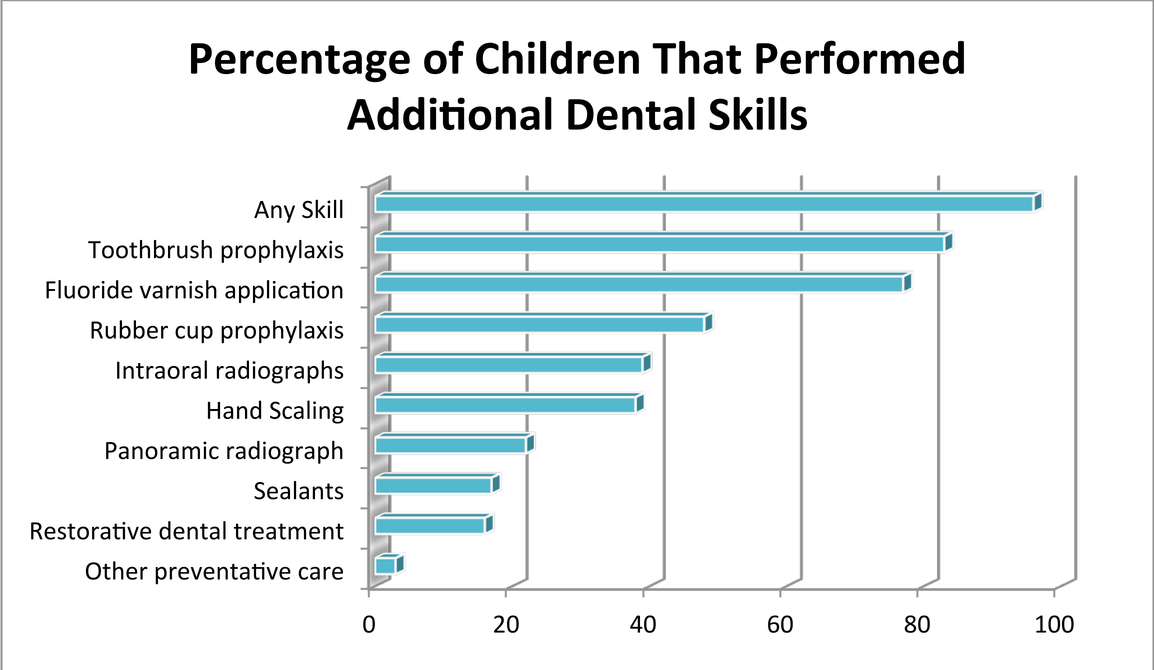
	Total # of clinic visits				
MTE	**1-2 N (%)**	**3-6 N (%)**	**≥7 N (%)**	**Total N (%)**	**Fisher's Exact Overall P-Value**
Never Failed	26 (19%)	73 (53%)	11 (8%)	110 (80%)	
Failed and Regained at end of Study	0 (0%)	7 (5%)	10 (7%)	17 (12%)	
Failed and did not regain at end of study	1 (1%)	7 (5%)	3 (2%)	11 (8%)	
Total	27 (20%)	87 (63%)	24 (17%)	138 (100%)	<0.01

Table 4: Additional Dental Skills Obtained During Study Period and Associated Descriptive Characteristics

Descriptive Characteristics	**Additional Skill**		
	Fluoride	**Rubber Cup Prophylaxis**	**Intraoral Radiographs**
Age (years)			
4-6	40 (73%)	22 (40%)	15 (27%)
7-12	48 (80%)	31 (52%)	14 (61%)
13-18	18 (78%)	14 (61%)	15 (65%)
p- value	*0.66*	*0.20*	*<0.01*
ASD Severity			
Mild	25 (78%)	20 (63%)	23(40%)
Moderate	44 (76%)	25 (43%)	23 (40%)
Severe	17 (65%)	9 (35%)	5 (20%)
Missing	20 (91%)	13 (59%)	9 (41%)
p- value	*0.53*	*0.09*	*0.03*
Clinical Visits			
1-2	13 (48%)	7 (26%)	7 (26%)
3-6	78 (90%)	51 (59%)	39 (45%)
7+	15 (63%)	9 (45%)	8 (33%)
p- value	*<0.01*	*<0.01*	*0.18*

FIGURES

Figure 1
Percentage of Children That Performed Additional Dental Skills



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