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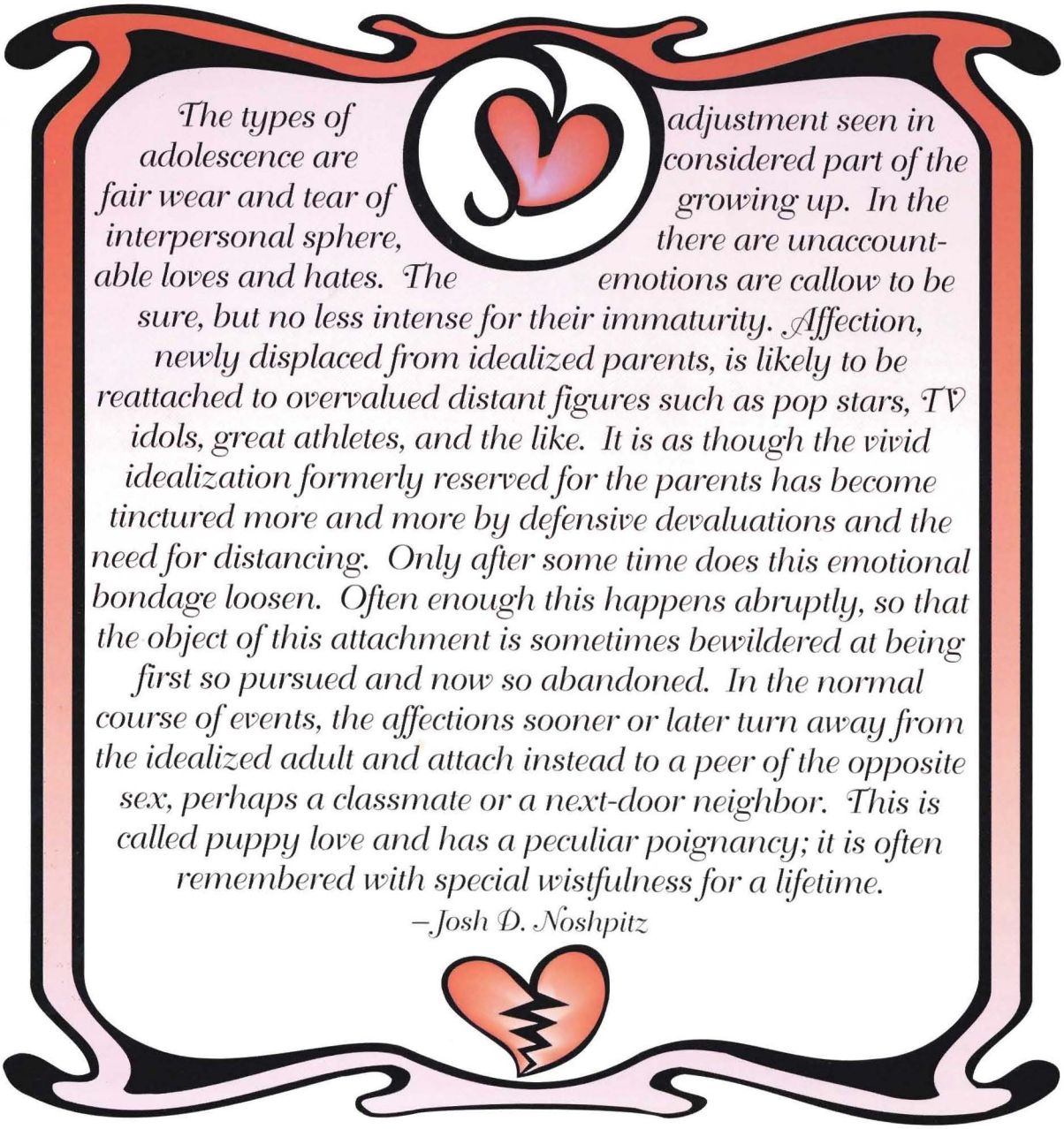
JOURNAL OF DENTISTRY FOR CHILDREN
MAY–JUNE 1993



The types of adolescence are fair wear and tear of interpersonal sphere, able loves and hates. The adjustment seen in considered part of the growing up. In the there are unaccount- emotions are callow to be sure, but no less intense for their immaturity. Affection, newly displaced from idealized parents, is likely to be reattached to overvalued distant figures such as pop stars, TV idols, great athletes, and the like. It is as though the vivid idealization formerly reserved for the parents has become tinctured more and more by defensive devaluations and the need for distancing. Only after some time does this emotional bondage loosen. Often enough this happens abruptly, so that the object of this attachment is sometimes bewildered at being first so pursued and now so abandoned. In the normal course of events, the affections sooner or later turn away from the idealized adult and attach instead to a peer of the opposite sex, perhaps a classmate or a next-door neighbor. This is called puppy love and has a peculiar poignancy; it is often remembered with special wistfulness for a lifetime.

–Josh D. Noshpitz

WE ARE NEVER SO DEFENSELESS AGAINST SUFFERING AS WHEN WE LOVE.

—Sigmund Freud

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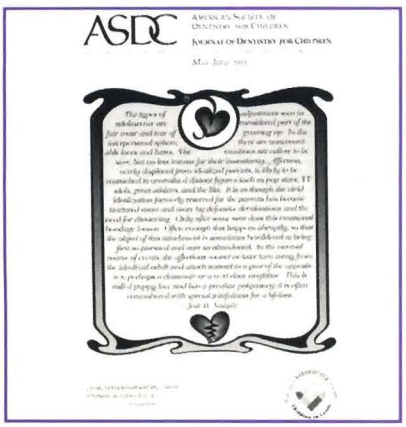
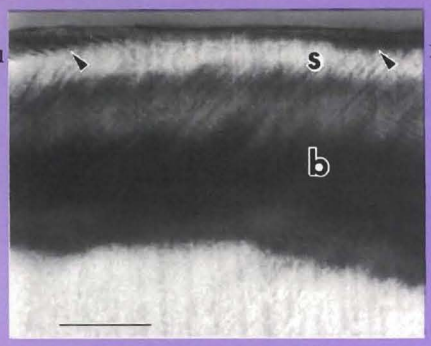


Emotional attachment is often abruptly transferred from parent to new idol with obvious abandonment of the former.

Art and design by Sharlene Nowak-Stellmach.

BEHAVIOR

SEALANTS



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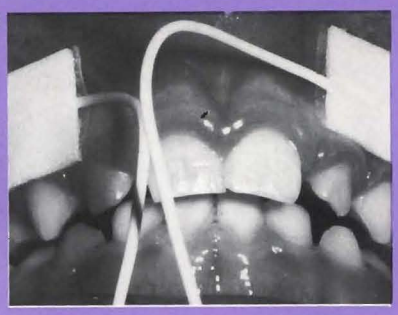

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CLINIC

DEMOGRAPHICS

DIETARY EROSION

For the busy reader

The roles of requests and promises in child patient management—page 169

When it became apparent that preventive measures would have a dramatic effect on pediatric dental diseases, the recommendation that a child's first dental appointment be at three years of age became clinically obsolete. Three years of age is too late to address the preventive needs of children with abusive nursing habits, destructive snacking habits, among others.

Requests for reprints should be directed Dr. Jimmy R. Pinkham, Professor and Head, Pediatric Dentistry, University of Iowa, College of Dentistry, Iowa City, IA 52242.

Dental treatment of fearful children using nitrous oxide. Part 3: Anxiety during sequential visits—page 175

The authors were interested in determining the effects of nitrous oxide when treating highly fearful children. It was decided to focus on the youngest age-group capable of verbally communicating with the dentist. The authors examined the extent to which the use of nitrous oxide contributes to the management of behavior.

Requests for reprints should be directed Dr. J.S.J. Veerkamp, Department of Pediatric Dentistry, ACTA, Louwesweg 1, 1006 EA Amsterdam, The Netherlands.

Project USAP - Part III: Practice by heavy users of sedation in pediatric dentistry—page 183

This part of the project was designed to examine the use of drugs by heavy users of sedation in pediatric dentistry. The twenty-five participants submitted data on 729 subjects, most of them medically normal with a mean age of fifty-eight months. Most practitioners used one particular drug combination. Nitrous oxide was used for 78 percent of the sedations; restraints in only a third of the time.

Requests for reprints should be directed to Dr. Milton I. Houpt, Professor and Chairman, Department of Pediatric Dentistry, UMDNJ, New Jersey's University of the Health Sciences, New Jersey Dental School, 110 Bergen Street, University Heights, Newark, NJ 07103-2400.

Effectiveness and acceptance of electronic dental anesthesia by pediatric patients—page 186

Transcutaneous electrical nerve stimulation was developed for dental use as a modification of TENS units, which are used for analgesia and stimulation in physical therapy. Electronic dental anesthesia is a more recent development, suitable for use in dental treatment. The purpose of this clinical trial was to determine the efficiency and acceptance of EDA when utilized for pediatric patients.

Requests for reprints should be directed to Dr. Joseph R. Jedrychowski, Professor of Pediatric Dentistry, UCLA School of Dentistry, Center for Health Sciences, Los Angeles, CA 90024-1668.

Effects of delegation, state practice acts, and practice management techniques upon sealant utilization: A national survey of pediatric dentists—page 193

The study was done to determine the practice management variables that influence the use of sealants among pediatric dentists. Twenty-one variables were examined in three groups: five primary variables, nine management variables, and seven practice variables.

Requests for reprints should be directed to Lt. Col. Frank J. Foreman, Chief of Pediatric Dentistry, 343 Med. Gp/SGD, 3349 Central Avenue, Ste. 1, Eielson AFB AK 99702-2325.

Caries-like lesion initiation and progression in sound enamel following argon laser irradiation: An *in vitro* study—page 201

There has been a recent resurgence of interest in the role of lasers in prevention and treatment of enamel

and dentinal caries. At relatively high energy levels, it is possible to produce a surface melt and effectively seal an enamel or dentinal surface, while producing only a 4° C increase in pulpal temperature. In this study the depth of the body of the lesion was reduced by 41 percent for those lesions exposed to argon laser irradiation.

Requests for reprints should be directed to Dr. M. John Hicks, Assistant Professor, Department of Pathology, Texas Children's Hospital, Baylor College of Medicine, Department of Pediatric Dentistry, Dental Branch, University of Texas Health Science Center at Houston, 6516 John Freeman Avenue, P.O. Box 20068, Houston, TX 77225-0068.

Eruption problems: A cautionary tale—page 207

Eruption problems affecting two male infants are described. The histopathologic report on the first case identified it as a pyogenic granuloma. The report on the second case indicated that the lesion resembled a pyogenic granuloma.

Requests for reprints should be directed to Dr. June H. Nunn, Department of Child Dental Health, The Dental School, Framlington Place, Newcastle Upon Tyne, NE2 4BW England.

Dental erosions caused by gastroesophageal reflux disease in children—page 210

Seventeen children suffering from gastroesophageal reflux disease were studied for the extent of dental erosion occurring. In two additional patients, the observation of dental erosion led to diagnosis of the disease. Primary incisors showed white spots or etching. The incisal edges were thinned or grooved. Chalky and opaque lesions were seen in many areas on the primary teeth; and small holes on the occlusal surfaces.

Requests for reprints should be directed to Dr. Liisa Aine, Department of Oral and Maxillofacial Surgery, University Hospital of Tampere, Tampere, Finland.

The health of our children and their use of medical services—page 215

There is a continuous flow of data from national health surveys providing details on illnesses of children and their use of health services. Pediatric practitioners must continue to expand their awareness of factors beyond the traditional limiting concerns of dentists.

Requests for reprints should be directed to Dr. H. Barry Waldman, Professor and Chairman, Department of Dental Health, School of Dental Medicine, State University of New York at Stony Brook, Stony Brook, NY 11794-8715.

Increasing enrollment of very young children in educational programs— page 220

Because of a greater proportion of the population of very young children involved in early educational experiences, pediatric dental practitioners in the 1990s will be serving a population of children that may be quite different from the children served by their predecessors in the 1970s and 1980s.

Requests for reprints should be directed to Dr. H. Barry Waldman, Professor and Chairman, Department of Dental Health, School of Dental Medicine, State University of New York at Stony Brook, Stony Brook, NY 11794-8715.

Increased acidity in frozen fruit juices and dental implications—page 223

Liter cartons of 100 percent juice commercially available fruit juices were purchased at different times and at different retail outlets over a period of six months. The first 100 ml of defrosted juice were tested for pH. It was concluded that the acid buffering capacity of fruit juice is increased by freezing and iced confection based on fruit juice is potentially detrimental to teeth.

Requests for reprints should be directed to Dr. L.Z.G. Touyz, Dental Faculty, McGill University, 740 Docteur Penfield, Montreal, P.Q., H3A 1A4 Canada.

BEHAVIOR

The roles of requests and promises in child patient management

Jimmy R. Pinkham, BS, DDS, MS

One of the constitutive elements of a dental appointment for a young child is the element of the unknown. When a child first meets a dentist, the sequence of events at the dental appointment unfolds in a way significantly different from what occurs during the interface of the child with any other adult, even the child's physician. The child's posture in the chair; the dentist's posture which is often at the 12:00 position or, in other words, upside down; the need to maintain an open mouth; the sights; sounds; smells, etc are an extreme departure for the child from any previous experiences. Dentists have understood this for years. Accordingly, pediatric dentistry has grounded itself in very firm behavioral techniques that allow a dentist to educate a child about the expectations of an appointment, while simultaneously assuring the child that everything will be fine.

In fact it was the ability of dentists to discover satisfactory behavioral techniques that supported the prediction decades ago that the most reasonable age for the first appointment should be three years old or slightly older. This conclusion was based entirely on behavior. Even the most skilled dentists in behavior management found that under three years of age their chances for successful behavior management dropped precipitously month by month as time of birth was approached. Between thirty-six and forty months of age and later, however, those clinicians who had become competent in talking with children, guiding their behavior, and intercepting avoidance behavior found great success.

It should be pointed out that the behavior management issue in dentistry for children preceded the prevention movement by almost half a century. When it became obvious that prevention strategies would have a remarkable and dramatic pediatric impact on dental diseases, the three-year-old behavioral guideline for the first appointment became archaic. Three years of age is too late to address the prevention needs of certain children, such as a child with an abusive baby bottle habit, destructive snacking patterns, significant fluoride supplementation needs, etc.

It could be argued that today's three-year-old probably comes to the dental office with significantly more knowledge about dentists and the expectations of the dental appointment than did the child of fifty years ago. There are numerous books that can acquaint a child with what a dental appointment is all about and do it in a very nonintimidating way. In addition, several popular children's television shows present a nonthreatening orientation to a dental appointment. Also, there are the themes of public service announcements that air throughout National Dental Health Month. Lastly there are a significant number of advertisements on television that portray dentistry as a nice experience for the child and something that is not only desirable but can also be fun.

Every dentist practicing a significant amount of dentistry for children today knows, however, that behavior management remains important particularly in restorative treatment, pulp therapy, and surgical appoint-

Dr. Pinkham is Professor and Head, Pediatric Dentistry, University of Iowa, College of Dentistry.

ments. This paper addresses the ongoing need for behavior management of children and examines those techniques that spelled success for a movement to provide dental care for children, starting more than seventy years ago. The appropriateness and usefulness of these techniques today will be analyzed. In addition, this paper will

- ☐ Address the question of why dentists should be concerned about using certain assertive techniques.
- ☐ Attempt to frame some provocative insights about what dentistry and society would like done behaviorally in the dental office.

BASIC MANAGEMENT TECHNIQUES

It is submitted that in the origins of the dentistry for children movement, there were three categories of behavior management techniques in which dentists learned to interface successfully with children behaviorally. These have been a part of dentistry's interface with children since the movement started in earnest after World War I. The three categories are desensitization, flooding, and reinforcement. They are still important today.

The "Old" Techniques that Predicted a Successful Dentistry for Children Movement

*1. Preappointment experience
*2. Tell, show, do
**3. Voice control
**4. Hand-over-mouth
**5. Towel techniques
**6. Physical restraint
***7. Praise, communications, etc.
***8. Gifts

*Desensitization
**Flooding
***Reinforcement

Desensitization literally means to take away one's sensitivity to something(s), which in the dental experience would mean the emotions and/or fears of the unknown included in the symbolism associated with the chair, tools, sounds, etc. Effective desensitization would mean that these emotions would be eliminated or at least reduced. Flooding is a psychological term meaning there is a subject and a master and that the master gives the subject great freedom to pick behaviors until the subject picks the wrong behavior.[1] Then the master becomes a "flooder" and intercepts (prevents) the behavior of the subject and directs it to a more appropriate behavior. A parent who physically lifts her child up from the pavement of a road and puts him back in the yard is flooding. So is the parent who yells out the front door "Get back into this yard and out of that street!" Reinforcement means that a behavior of a child is rewarded either by verbal commendation or some other means such as a prize.

There are historically two primary desensitization techniques in dentistry for children: preappointment experience, and tell, show, do. Preappointment experience, which was practiced more in the past than today, means that the child has the opportunity without jeopardy to inspect the office, ask questions, meet the personnel, etc. Tell, show, do is a basic technique in all health sciences and is appropriate for all age-groups. It is very appropriate, however, for the child. The technique assumes that a very careful explanation of a procedure and equipment must be given to the child before the procedure is done and the equipment is used. The "do" part of this technique asserts that for children (and this is often true of adults too) there may have to be an enactment procedure or a demonstration of the use of a tool, for the child to absorb what is being said. Running a prophy cup on one's thumb nail would be a "do" type of activity.

The flooding techniques are assertive. Voice control is a switch in the behavior of the clinician. Although it has been tied to tone of voice and perhaps the volume also, there is no question that it is more of an implicit control than explicit and has a lot to do with the mood and attitude of the clinician. Voice control is first and foremost a change in the attitude of the clinician that affects the clinician's behavior. This will be discussed in more detail in a moment. Hand over the mouth (HOM) is the technique of quieting a screaming child by muting his voice with the hand over the mouth. Despite the fact that this technique is considered too assertive and aggressive by some, it remains an endorsed technique for certain children by the American Academy of Pediatric Dentistry, as long as informed consent from the parent or guardian is available to empower the dentist to use the technique.[2] Towel technique is essentially the same thing as hand over the mouth. It is not to be construed as putting anything

into a child's mouth. Physical restraint ranges from holding down a child's hands during injection all the way to the utilization of stabilizing equipment like a Papoose Board. (Olympic Medical Corporation, Seattle, WA)

The last two techniques are in the reinforcement categories. These are praise and gifts. Praise can be part of an overall communication strategy. In this case desensitization and reinforcement are blended. Effective communication is distracting and distraction works as a process of desensitization.

QUESTS AND PROMISES DURING THE DENTAL APPOINTMENT

Human beings can engage each other behaviorally in a variety of ways. This ranges from conversational playing and entertaining, to educational discourse, to sexual arousal and sensual interplay, to intimidation. In the domain of "doing something", human beings rely upon words and/or gestures (which act out the words that the doers understand) to "get something done" . A dental appointment is a "do something" interface of two people, the dentist and the child, who need to get something done. Now in reality this need does not necessarily mean that either or both parties want to get something done. In fact, the fact that there is avoidance behavior by children (and by adults too) underscores the fact that the need is not necessarily bilateral and that often for the young child the want simply is not there.

When something needs to be done and the doer is in control or is at least an effective participant who has a chance of securing control, there is only one way (in its most basic analysis) the doer can ultimately secure a commitment from the other participant that will allow something to be done.[3] This is true in all human interactions based on something needing to be done. This is true of a football coach calling a football play; of a policeman in his squad car stopping a speeder; of a husband desiring his wife to bake a certain kind of cake; of a young business woman/mother wanting her husband to put the children to bed, while she works on a last minute report; and it is true of a dentist who needs the cooperation of a child in the dental chair. The basic premise of all of these situations and, in fact, of all human behavior seeking to accomplish something in cooperation with another person is that the initiating doer must make an effective request of the other person. The action of the responding person that allows the doer, in our case the dentist, to do something is called a promise. The promise establishes a commitment. Commitment is the bottom line of human cooperation.

There is a tremendously wide latitude of possible expressions of the words *request* and *promise*. Requests come in all shapes and forms of meaning, drama, and effectiveness. Requests can be seductive, weak, marginal, strong, unavoidable, etc. When a man approaches another man who owns a store and says "Give me your money", he is making a request. Upon not getting the money, when he pulls out a 38 magnum and points it at the temple of the owner, it could be said he is making a much more dramatic and effective request. When a parent tells a child to clean up his room, she is making a request. When she tells him "Clean up your room or be grounded!" she perhaps is making an even more effective request. On the other side, she could say "Clean up your room and I will pay you money" and that might strengthen the request also.

A dentist who tells a child "Get into the chair" is making a request. If a dentist says "Get into the chair, please" he is making perhaps a more effective request. The dentist who picks up the child (floods the child) and puts him into the chair is making a request also. This act, which can be done in silence, is just a dramatic follow through on the language of "Get into the chair".

The child is the responder to the requests of the dentist. To respond appropriately to allow dentistry to be done, the child will need to promise to follow through on the requests of the dentist. A child who jumps into the chair, opens his mouth, and copes with the rigors of a restorative appointment has effectively promised that he will follow through on the requests of the dentist. The child has made a commitment and followed through on it. The child who does not get into the chair has failed to promise any behavior or to make a commitment. It is on the failure of this promise to behave that the dentist must enact strategies to make his request more effective. In the end the assertive management of a child with such techniques as physical restraint or hand over the mouth are only ways of making more dramatic the request asked for in the previous conversations with the child. Assertiveness is dramatic communication.

ONTOLOGY OF CHILD MISBEHAVIOR DURING THE DENTAL APPOINTMENT (WHEN FEAR IS NOT THE PRIMARY ISSUE)

What is the ontology (i.e. the meaning and the being) of the child's inability to respond with an effective promise to the request of the dentist. Many people

would reflexively say fear. Their rationale would be based to some degree on the assumption that the dentist and dental appointment probably represent pain or possibility of pain to the child. Although this paper is not about fear of dentistry, it should be pointed out that there are many other things that promise the possibility of pain to a child, like bicycles and roller skates, but do not necessarily provoke an expression of anticipated fear. Furthermore, experience has taught most dentists who are well grounded in working with young children that their behaviors often center upon avoidance of things that the child knows from practical experience do not hurt, such as prophys, fluoride treatments, and examinations.

The use of fear

This paper does not deny that there are real fears associated with the dental experience. This paper does assert, however, that it is easy to utilize fear as a catchall, when indeed other explanations are plausible for why the child misbehaves.

Also, there are many situations in life, dentistry is one of them, where someone can choose to be afraid.[4] In such cases a response is not a biological/psychological one, but rather a linguistic one where the distinction of being afraid serves the individual well. For children wishing to sabotage their dental appointments, the fact that they choose to be afraid energizes them and gives them a pattern of avoidance (crying, coughing, sobbing) that is easy to do and by their assessment is what is needed. Misdirected children, as discussed in this paper, find practical uses in keeping themselves afraid of certain expectations of life. In fact it can be concluded that some become expert pitymongers.

So, in practical scenario on a given afternoon, a dentist could see a variety of three-to-four-year-olds and use the very same technique on all these children and find there was a range in behaviors from complete compliance to dramatic avoidance. With the child who shows complete compliance, the dentist is usually using very simple and sometimes unspoken requests. For the child who is showing some degree of lack of promising committed behavior, the nature of the requests may be made more dramatic by voice control (implicit control).[5] For the child who is determined not to promise compliance (commitment), the dentist will see dramatic avoidance behavior. This reluctance to promise cooperation can be expressed as a tantrum, obstinacy, screaming, kicking, and being sick. In these situations ways to dramatize the intensity of the dentist's requests must be brought forth. Hand over the mouth is simply a way of dramatizing for the child that the request is very, very serious. It is not about hurting or scaring the child. Instead it is about communicating with the child. It is very important for parents to understand that what is happening here is simply an extension of the way an adult authority figure is talking to a child who needs the care that this adult authority figure has been trained to deliver.

In this last instance of the misbehaving child who needs care and yet does not react to simple requests and for whom the parent will not empower the dentist to dramatize this, the dentist will have to do it some other way. This may be done with conscious sedation or it may require a trip to the hospital. The conscious sedation or anesthesia for this kind of management problem essentially takes away the child's resolve to not promise cooperation with the requests of the dentist. It does not secure compliance. It only "puts to sleep" the resolve of a noncompliant strategy by the child.

Is it predictable what kind of child is a poor promiser to the reasonable requests of adults within his/her world? The answer here is affirmative. The conclusions of Alfred Adler in the earlier part of this century and Rudolph Dreikurs later give strong hints about misdirected children who by their very assumptions about themselves are likely to challenge the requests of any adult authority figure.[6-11] These children started by challenging their parents. The dentist is only an extension.[12,13] (It should be pointed out that very few people other than parents make any requests of preschool children in American society today. This was not necessarily true in an agrarian, postfigurative society where children were pushed into the work force very early or even in early industrial societies where children also were recruited into the work force early. Requesting adults are as rare as hens' teeth in the world of many American children today.)

Adler first generally explained and Dreikurs specifically elaborated upon later that the four misdirected goals of childhood are as follows:

- ☐ Attention getting.
- ☐ Attention getting by power struggle.

☐ Attention getting by retaliation and revenge.
☐ Attention getting by acting out inadequacy.

All four of these categories of misdirected children may have a tendency for misbehavior, when requests for compliance are made. The attention getting child may not respond to a request just because by not responding he is able to satisfy his social need to be in control. For the purpose of this paper, this child is to be regarded, however, as a minimal problem in that the attention getting child is modestly misdirected and that most of the requests by the dentist are attention giving behaviors anyway.

The child who struggles for power, however, is an arguer and a tantrum prone child. This child may reflexively not respond to the requests of a dentist. Defiance to adult authority may seem instinctive. This is a primary experience this child has had to adult authority.

This is certainly true also of a revengeful child who lives in a constant discourse with himself about disliking people and wanting to get even with them. The child lives with an assessment of not liking other people. Only by acting out his anger can the child satisfy any degree of self-esteem.

The last child, the child of inadequacy, lives with a constant assessment that he fails to measure up in any way. Requests by the dentist, that the child find the where-with-all to meet new expectations of himself, therefore, are reflexively denied. This child finds himself unable to promise anything that is a modification of past or present behaviors. He acts out again that he is special in the worst sort of way, "I can't do anything right."

In summary, the following mottos are applicable to these four types of misbehaving children:[14]

Goal 1: *Attention*	"I'm not outstanding, but at least I will not be overlooked if I can obtain special attention, fuss, or service.
Goal 2: *Power*	"I may not be a winner, but at least I can show people that they cannot defeat me, or stop me from doing what I want, or make me do what they want."
Goal 3: *Revenge*	"People do not care for me, but at least I can do things to strike back when I am hurt."
Goal 4: *Inadequacy*	"I will not be able to measure up, but at least if I do nothing people may let me alone."

The linguistic nature of homo sapiens

These background discourses are really recurrent conversations that the child has with himself and are begun early in childhood. They are a part of the linguistic nature of homo sapiens. Borrowing from the tenets of the German philosopher Martin Heidegger's phenomenology and language, it can be asserted that these conversations become the bedrock of personality.[5] To change the child who practices avoidance behaviors in the dental office will mean to change the linguistic ontology of the child. This process will be, as is true in all biology, spread over a normal curve for a population of children. Some children will change easily and others may be reluctant to change at all.

Alfred Adler believed with conviction, as did his student Rudolph Dreikurs, that a child assumes the foundation motives of his personality very early in childhood and the occurrences happening in the child's home are paramount, therefore, in assessing a child's personality. Adler further felt that the way the child learned to interface with his parents would have broad carry-over to other adults. In other words, the child who argues with his parents will be expected to argue with people in general; the child who is polite with parents would be polite to others; etc.

It was argued by Dreikurs that the four misdirected goals of childhood were more likely to surface when parenting was ineffective.[9] It is the conclusion of this author that the advent of a prefigurative society as it relates to children as argued by Margaret Mead and explained in previous publications in this journal has predicted an increased number of children aversive to adult authority.[16-18]

SUMMARY

It is typical for some to assess the misbehavior of children in the dental appointment to be exclusively for reasons of fear. Such an assessment is offered in this paper to be naive. Fear certainly can be a predictor of avoidance behavior, but avoidance behaviors are often found in child dental patients who are remarkably well acquainted with dentistry and who know that the procedures that lay ahead for them are in no way painful or fearful at all.

In the case of a recalcitrant child patient, the mechanism by which human beings get things done with other human beings, requests and promises, does not work because of the child's aversion to adult authority. It is submitted that there are children who are poor promisers, because of a background discourse that they have with themselves that makes it difficult for them to interface effectively, i.e. by making effective promises, with other people. Since the dentist is a requester and the dental appointment works by requests, these children are reliably problem patients. They cannot make commitments to cooperate.

Four types of children have been described who by a misdirected goal of their childhood, which they have absorbed early, are reliable predictors of misbehavior and avoidance behavior during dental appointments. The internalized goal makes cooperation with a requesting adult difficult. This fact is often seen perhaps in the dental office first, because in our society today very few requests are made of our preschool children.

Lastly, it should be noted that the more aggressive techniques in pediatric dentistry are techniques that dramatize the importance of the request and the earnestness by which a dentist (and perhaps the parents too!) wishes the child to respond to the request. The assertive management of children by the dentist has nothing to do with punishment, or anger, or pain, or fear: these are all inaccurate analyses. Assertive management by a dentist is a method of dramatizing a previous request to the child. Through assertion the dentist seeks a promise of the child to cooperate, a commitment to dance with the circumstances. The assertive technique should be considered nothing more and nothing less.

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CRASH INVOLVEMENT AMONG MOTOR VEHICLE OCCUPANTS YOUNGER THAN 5 YEARS

Our data indicate that the absolute number and the proportion of nondriver occupants younger than 5 years old increased from 1984 to 1990, as did fatalities and fatal crash involvements among children in this age group. In an earlier era, children younger than 5 years old were generally unrestrained in motor vehicles. The trends presented here should not be interpreted as indicating that child safety seats or other restraints have been ineffective, but rather that the risk of children in this age group being involved in a fatal crash has increased more than would be expected on the basis of increases in their numbers among the general population. As health care providers and as educators, clinicians must be aware of the changing environments to which their pediatric patients are exposed and of the need for advocacy and encouragement of parents regarding safety measures to protect children in these environments.

Chorba, T.L. *et al*: Increases in crash involvement and fatalities among motor vehicle occupants younger than 5 years old.
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Dental treatment of fearful children using nitrous oxide. Part 3: Anxiety during sequential visits

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It is impossible to imagine modern dentistry without nitrous oxide. Whereas originally nitrous oxide was mainly used for its possible analgesic capacities, over the years the emphasis has shifted more and more toward its relaxing effects and the function it performs as a support for the various techniques for influencing behavior of moderately fearful patients.[1-4] How successfully nitrous oxide can be used upon extremely fearful patients is uncertain.[2] It is reported that although nitrous oxide does not interfere with the contact between the child and the dentist doing the treatment, it ceases to help if a child panics, which is particularly likely to occur in the case of patients who are already extremely fearful.[2,3] There is a lack of research specifically concerned with the treatment of this group of children.

In addition most research fails to answer the question of long-term effects. Instead, usually the child's direct reactions to the behavior of the dentist or vice versa, or carry-over effects during treatment programs involving a very limited number of sessions are emphasized.[1,2,5,6] It is considered that a follow-up to the treatment programs would be useful, to see whether the strategies used remain effective over time, and whether learned behaviors are maintained. In a review article, Corah states: "Assessment of repeated behavioral strategies applied over a series of treatment visits is required. Such studies are important because we do not know if intervention strategies become more effective...".[7]

The pediatric use of nitrous oxide is not specifically directed to a particular age. Generally speaking, an age is chosen at which the child has sufficient verbal and cognitive skills to be given a proper explanation of the treatment and to understand it. It is also easier for the dentist doing the treatment, if he can influence the child's imagination by the use of suggestions.[4]

The objective of this study is to determine the effects of nitrous oxide when treating highly fearful children. In order to be able to make an effective comparison with behavioral management, it has also been decided to focus on the youngest possible age at which the child has sufficient verbal skills to be able to communicate with the dentist and at which the child's focus of attention is beginning to move more toward his/her surroundings. For these reasons, both relatively younger children (between 6 and 6.5 years old) and older children (between 8.5 and 11 years old) are included in this study. The study examines the extent to which nitrous oxide makes an extra contribution to behavioral management, and the extent to which the child's be-

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havior changes in relation to time. The behavior of the children was observed, therefore, during the period that they were undergoing treatment.

MATERIALS AND METHODS

For this study fifty-five highly fearful children who had been referred to our dental fear clinic were selected. In all cases the reason for their referral was that their dental treatment had been discontinued because they were untreatable due to their behavior. The children were between six and eleven years old, and in normal primary education. The selection criteria, the method of selection, the preconditions for treatment, and sequence of treatment have been described at an earlier date.[8-9] Selection of the children was accomplished during a separate consultation by a dentist who took no further part in the study.

The children were randomly divided into two groups, matched by sex and age: one group to be treated with behavioral management only (control group), the other with behavioral management and nitrous oxide sedation (experimental group).

They were treated by two experienced pediatric dentists, each of whom had six years of experience in managing fearful children.[8] Allocation of child to dentist was also carried out randomly. No account was taken of the child's or parents' preference.[8] Both dentists treated approximately equal numbers of children from each of the two treatment conditions.

Treatment conditions

To standardize the treatment conditions, a few additional decisions had to be made:

- ☐ No parents were allowed to be present during the treatment (to prevent the child from being influenced by the behavior or the presence of the parent).
- ☐ The dental assistant was not allowed to communicate with the patient (to make sure the only verbal or nonverbal contact was between the child and the dentist).
- ☐ Conservative treatment was given with the use of rubberdam and anaesthetic.

The first session (introduction) was used to familiarize the child with the treatment procedures and with inhalation sedation, where this was relevant.[8] Curative treatment did not begin until the dentist judged that the child was ready for it, and not before the second session.

Scoring procedure and clinical ratings

The habituation and treatment of the group of children lasted for between three and ten sessions, spread over a period of one to five months. All the sessions were videotaped, using a fixed auto focusing camera with a built-in clock. The behavior of the treated children was scored on the basis of these video recordings.‡ Each tape was observed from the beginning of treatment to five minutes after the tooth preparation commenced, for a minimum of fifteen minutes. In addition to this, the entire tape was watched, if further major operations (such as an extraction) could be expected to follow.

The tapes were scored by a dentist and a psychologist, both unaware of the objective of the study. They had been given extensive training, using videotapes not included in the study. Processing did not begin until after the final session was completed. For the final analysis, small differences between the numbers of patients may occur due to camera failures. The tapes were evaluated independently (Pearson's correlations between .90 and .97) and in case of disagreement the final score was made by joint decision.

The measuring instrument described by Venham *et al* was chosen for the evaluation.[6] Because the children in this study belonged to a different (older) age-group, a number of modifications had to be made, most of which were concerned with the older group's more oral expressions of fear and their generally greater degree of self-control in frightening situations (Figure 1). Venham made a distinction between behavior and fear scores. These scores were found to correlate highly, and this finding was also replicated in subsequent research[2-9] It was decided to use a single fear score in the present study based on the behavior displayed.

A score for the child's level of fear during a session was given on a six-point scale, ranging from 0 (relaxed) to 5 (no further contact possible); this was the overall score (OS). This score indicates the behavior of the child during the whole treatment session. A score was also given for the moment during that session at which the child behaved the most fearfully: this was the peak score (PS). The evaluators were instructed to exclude this peak score when awarding their final overall score. This was done in order to prevent the score for a mo-

‡To process the video material, a total of 300 hours of recordings made of 668 sessions were watched. It was decided that the observers should not watch the tapes for more than twelve hours a week (four half days) because of the risk of fatigue. The observers were employed for this amount of time over a period of eight months.

0 RELAXED *Smiling, willing, able to converse, best possible working conditions. Displays the behavior desired by the dentist spontaneously, or immediately upon being asked.*

1 UNEASY *Concerned. During stressful procedure may protest briefly and quietly to indicate discomfort. Hands remain down or partially raised to signal discomfort. Child willing and able to interpret experience as requested. Tense facial expression. Breathing is sometimes held in ("high chest"). Capable of cooperating well with treatment.*

2 TENSE *Tone of voice, questions and answers reflect anxiety. During stressful procedure, verbal protest, (quiet) crying, hands tense and raised but not interfering much. Child interprets situation with reasonable accuracy and continues to work to cope with his/her anxiety. Protest more distracting and troublesome. Child still complies with request to cooperate. Continuity is undisturbed.*

3 RELUCTANT *Tends to reject the treatment situation, difficulty in assessing situational threat. Pronounced verbal protest, crying. Using hands to try to stop procedure. Protest out of proportion to threat or is expressed well before the threat. Copes with situation with great reluctance. Treatment proceeds with difficulty.*

4 ANXIOUS *Anxiety interferes with ability to assess situation. General crying not related to treatment. Prominent body movements, needing physical restraint on occasion. Child can be reached through oral communication, and eventually with reluctance and great effort begins to work to cope. Protest disrupts procedure.*

5 OUT OF CONTACT *Fails to grasp the reality of the threat. Hard, loud crying. Screaming, swearing. Unable to listen to oral communication. Regardless of age, reverts to primitive flight responses. Actively involved in escape behavior. Physical restraint required.*

Figure 1. Venham's clinical ratings of anxiety and cooperative behavior.

ment of fear about a single part of the treatment (e.g. anaesthesia) from dominating the score for a session as a whole. If one of the characteristics specified on a given scale (Figure 1) was observed together with another characteristic from a different scale during evaluation of the behavior of a child, the highest score was noted if a peak value was concerned, and the most frequently recurring behavior was used for the overall score. The main concern of the peak value was whether a child displayed fearful behavior for short periods. It was important, therefore, that the child had a lower score both before and after the peak value.

The fear scores for the curative sessions were taken as the base when processing the scores. This was based upon the assumption that sessions with a less invasive character could possibly have an effect upon the children's fear, but that fear can ultimately be most clearly gauged from their behavior during a curative session.

Six dependent variables were finally included in the main statistical analysis:

- ☐ OSl: Overall score for the first curative session.
- ☐ PSl Peak score for the first curative session.
- ☐ OSA Average (curative) overall score.
- ☐ PSAi Average (curative) peak score.
- ☐ OSL Overall score for the last curative session.
- ☐ PSL: Peak score for the last curative session.

In order to determine the changes in fear levels between the first and last sessions, the intervening sessions were also evaluated (OS2, OS3, OS4, PS2, PS3, PS4). Because the size of the groups diminished as the number of sessions increased, only the fear scores for the first and last sessions of each child and the average were used for the main analyses. Statistical analyses were performed by using SPSS/PC+V2.0.[11]

RESULTS

Table 1 gives the average overall scores and the associated standard deviations for the first and the last sessions of the curative treatment phase, and the average of all curative sessions (OSl, OSL and OSA). The scores were calculated separately for the control condition (behavioral management) and for the experimental condition (nitrous oxide). Table 2 gives the same information for the peak scores obtained during the treatment phase (PS1, PSL and PSA). Figure 2 represents this in graphic form.

The data given in Table 1 show a significant fall in the overall fear scores of the control condition ($p = 0.019$) between the first and last sessions of the treat-

Table 1 ☐ Differences between overall scores for the experimental condition (treatment with N_2O) and the control condition (behavioral management), corrected for age as covariable.

	B.M. (n = 25)		N_2O (n = 27)			
	X	s.d.	X	s.d.	p)*	F
OS1	2.60	1.15	1.48	1.19	.003	8.52
OSL	2.00	1.04	1.48	1.01	n.s.	.61
OSA	2.16	.80	1.55	.92	.035	3.44

Anova; sign. if $p \leq 0.05$.

Table 2 ☐ Differences between peak scores for the experimental condition (treatment with N_2O) and the control condition (behavioral management), corrected for age as a covariable.

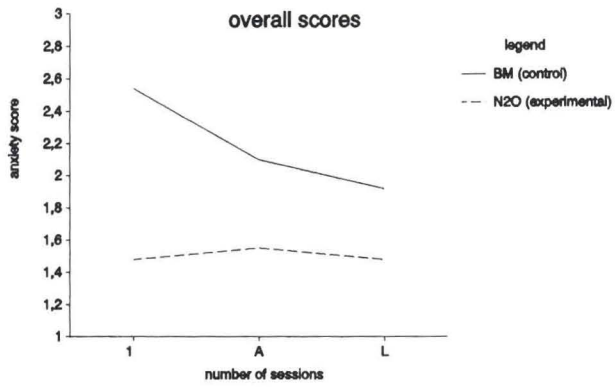
	B.M. (n = 26)		N_2O (n = 27)			
	X	s.d.	X	s.d.	p)*	F
PS1	3.69	1.23	2.19	1.33	.001	12.32
PSL	2.69	1.32	1.93	1.30	n.s.	1.49
PSA	3.23	.92	2.33	.96	.006	6.78

Anova; sign. if $p \leq 0.05$.

Table 3 ☐ Average of peak scores in relation to age categories.

Group	Age category	PS1 X (s.d.)	PSL X (s.d.)	PSA X (s.d.)
1 (n=21)	≤ 6.5 yrs.	3.52 (1.29)	3.19 (1.44)	3.36 (.73)
2 (n=17)	6.5-8.5 yrs.	2.71 (1.49)	1.76*(.90)	2.50*(.95)
3 (n=17)	≥ 8.5 yrs.	2.24*(1.44)	1.76*(.97)	2.31*(1.15)

* Differs significantly from the score for Group 1 (One-way, signif. at $p < 0.05$).



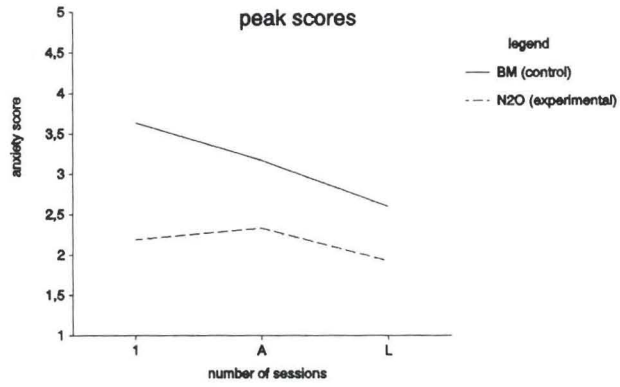


Figure 2. Graphical presentation of Tables 1 and 2.
1 = score of the first session
A = average score
L = score of the last session

ment phase. In Table 2 the same is shown for the peak scores of the control condition ($p = 0.001$). The experimental condition (treatment with nitrous oxide) shows a completely steady profile. No significant differences between the first and the last sessions were observed. In comparison with the control condition, both the overall scores and the peak scores of subjects in the experimental condition were already significantly lower during the first session. The average scores (OSA, PSA) for the treatment phase as a whole were also significantly lower, when the treatment was supported with nitrous oxide. Only for the last session, the

A significant fall in overall fear scores occurred between the first and last treatment visits.

Table 4 ☐ Overall scores (max. score = 5) for the control and experimental conditions.

	B.M. (n=24)		N_2O (n = 27)	
	X	s.d.	X	s.d.
OS1	2.54	1.14	1.48	1.19
OS2	2.25	1.11	1.44	1.25
OS3	2.13	0.90	1.52	1.16
OS4	1.75	0.90	1.48	1.01
OSL	1.92	0.97	1.48	1.01
OSA	2.10	.75	1.55	0.92

Table 5 ☐ Peak scores (max. score = 5) for the control and experimental conditions.

	B.M. (n = 24)		N_2O (n = 27)	
	X	s.d.	X	s.d.
PS1	3.64	1.22	2.19	1.33
PS2	3.40	1.26	2.48	1.28
PS3	2.96	1.06	2.56	1.45
PS4	3.08	1.29	1.96	1.19
PSL	2.60	1.26	1.93	1.30
PSA	3.17	0.89	2.33	0.96

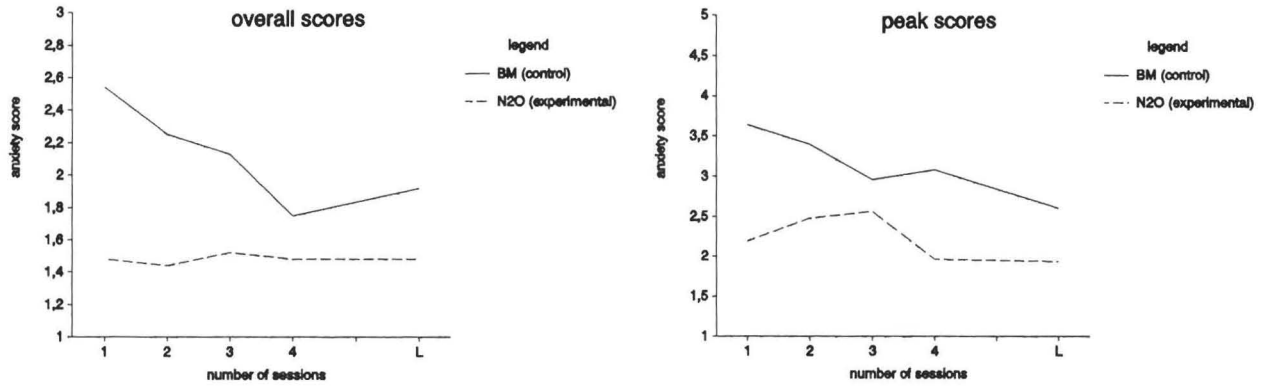


Figure 3. Graphical presentation of the progress of fear scores during the sessions of the treatment phase. L = score of the last session

scores for treatment with nitrous oxide were not significantly different from those of the control condition, for both the overall and the peak scores.

A further analysis of the data investigated whether correlations with any covariables were present. First, the composition of the groups (sex), the number of weeks between two sessions, and the dentist giving treatment were examined: neither of these factors yielded correlations of any significance with the fear scores. A weak correlation, varying between .34 and .41, was found, however, between the child's age and the peak scores (PSl, PSL and PSA). Further examination of the correlations did show a clear correlation between the fear displayed during the first curative session (both for the overall score and for the peak score) and the fear displayed during the remaining curative sessions of the treatment phase (.66 and .68 respectively).

After dividing the patients into three age-groups approximately equal in size, further study showed that all the peak scores for the youngest group (Group 1, ≤ 6.5 years old) were found to differ significantly from the scores for the oldest group (Group 3, ≥ 8.5 years old). A significant difference was also found between groups 1 and 2 in the peak scores for the last session and the average peak score. Table 3 gives the specific data. Bearing in mind these differences in fear between the younger and the older children, the differences between the control and experimental conditions were tested again, but this time with the child's age as the covariable. This correction did not undermine the results found earlier; the fear level of the children in the control condition is clearly higher than the fear level of the children in the experimental condition. Further examination of the scores for the first sessions was considered to be desirable, in order to determine whether, when plotted graphically, the course of the fear displayed was regular and without outlying values. The course of the overall and peak scores can be seen in greater detail in Tables 4 and 5.

Once again, it can be seen how the fear scores for the control condition diminish regularly. The most marked fall, although not yet significant at that point,

Nitrous oxide reduces level of fear more quickly.

takes place between the first two sessions. The cumulative effect results in a significant difference between the second and third sessions. The scores in the nitrous oxide group are much more regular: this results in an almost horizontal graph.

DISCUSSION

In this study it was decided to take the child's behavior as the most important factor in evaluating his/her fear of the dentist, and not to use self-reports, i.e. not to use questionnaires as a measuring instrument, because in general children below the age of eight are not considered to be capable of coping adequately with questionnaires or interviews.[12,13]

Course of the fear scores

We can assume that the level of anxiety in both conditions at the moment of selecting the child is similar. It can be seen from the results given in Tables 1 and 2 and from Figure 2 that both behavioral management and sedation with nitrous oxide result in a significant reduction in fear at the end of the treatment phase. Sedation with nitrous oxide is a clearer aid, however, in reducing existing fear of the dentist, because it produces an immediate reduction in fear in the first session, judging by the child's behavior during the treatment.

The reduction in fear obtained during treatment with behavioral management alone is known from the literature, especially in the treatment of younger children (36-72 months).[10] This finding can be expanded by adding that in our group of children (ages between 6 and 11), this reduction in fear applies both to the most frightening moment during the session, and to the basic level of anxiety during the session as a whole. While the effect of behavioral management is a matter of time, treatment with nitrous oxide, however, results in consistently low scores (Tables 1,2,4,5 and Figure 2), both for the session as a whole and for the most threatening moment. This occurs immediately, from the first curative session. The fact that the peak scores in particular show a relationship with the child's age (Table 3) is an indication that younger children are probably less inhibited in their behavioral response to fear. This only occurs at the most frightening moment, and age appears to have no effect upon the overall level of fear, indicating that the child is able to distinguish between the more and less stressful parts of the treatment. The age effect that is present, combined with the effort involved in collecting and processing the video recordings made for the purpose of behavioral observation, does suggest, however, that it is probably worth considering the use of a simpler method with children over eight years of age; i.e., a standardized questionnaire could be used to determine the level of fear during dental treatment, instead of behavioral observation. This accords with the findings that from the age of ± 8 onwards, children have the mental capacity to answer a questionnaire.[12-14]

The clear correlation between the fear score for the first curative session and that for the remaining curative sessions for the same child indicates that the behavior of the child during a first session has a clear predictive value for the behavior that can be expected. The beneficial effect of nitrous oxide upon the overall fear scores is determined primarily by the child's behavior during the first few sessions. Nitrous oxide works more quickly and, as gauged by behavior, is thus more comfortable for the patient. At the end of the treatment, however, the use of nitrous oxide produces a degree of fear reduction still higher than psychologic behavioral management, but not significantly so. Nitrous oxide is thus a valuable aid for making highly fearful children treatable quickly. Nitrous oxide works immediately, whereas behavior modification only has a measurable effect in the longterm (Tables 1, 2 and Figure 2).

In order to study the course of the fear scores, the scores for the first four curative sessions were plotted on a separate graph. This restriction was chosen in order to keep the groups as complete as possible. The longer a program of treatment lasts, the larger the number of children who reach the conclusion of their treatment. The graphs are illustrative, therefore, while

only the variables mentioned under Materials and Methods are used for the actual calculations.

The amount of time consumed by this group of patients was reported previously.[8] Particularly during the first (habituation) phase of a patient's treatment, the use of nitrous oxide sedation required significantly more time. The question is whether the low level of fear already found during the first session for the nitrous oxide condition is the result of this greater investment of time, or of the direct medicinal effect of nitrous oxide. Doubleblind research reveals that it is the result of the medicinal effect.[3] The question to what extent a more effective patient treatment may demand more time and thus a greater financial investment is ethical in nature, and will need to be given more individual consideration.

Learning effect

The treatment of this group of fearful children ended at a comparable fear level for both the experimental and the control group. There were no cases in which children could not be treated according to the chosen treatment strategy on the grounds of untreatability. A significant degree of fear reduction based on a learning effect was found in the behavioral management group; the child learns that treatment conducted in a specific way, by a specific dentist, in a specific clinic is all right. The conditioned learning processes associated with the dental treatment gradually disappear. Only the child's fear of genuinely stressful events (injection, extraction) remains in evidence. In the nitrous oxide group, the fear is reduced more quickly and completely by the medicinal effect of nitrous oxide, which could undoubtedly produce an additional learning effect: besides the effects already mentioned, the effect is more likely to be attributed to the medicine. On the other hand, however, if a child takes a dependent attitude, she will always be able to find a cause outside herself to which the successful treatment can be attributed. In other words if habituation to nitrous oxide develops, the patient could also have become habituated to the person of the dentist, the surroundings, etc. Subsequent studies will need to report the extent to which fear reductions in children are enduring, before drawing more definitive conclusions on this subject. Separate research will also be needed to establish which character traits in a child are involved in habituation to dental treatment. Furthermore, study is needed to determine the ideal age at which behavior observation can still be used as the deciding criterion for fear.

CONCLUSIONS

- ☐ Dental treatment of highly fearful children, is carried out more successfully with nitrous oxide both for the session as a whole and for the most threatening moment, and this effect is produced immediately, from the first curative session. In the medium term (at the end of a program of treatment), fear reduction with nitrous oxide differs not significantly to that of behavioral management alone.
- ☐ Younger children behave more fearfully at the most frightening moment in the treatment. This behavior is independent of the use of nitrous oxide or the state of habituation to the treatment.
- ☐ The absence of a relationship in the younger children between the anxiety during the most frightening moment and the overall anxiety in this study might indicate that the child is already well able to distinguish between the different phases of treatment.
- ☐ A first curative session of a child who is very frightened of the dentist has a clear predictive value for the child's subsequent level of fear, during the following sessions of the treatment.

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AN ORTHOGRAPHIC LAMENT

If an S and an I and an O and U
With an X at the end spell Su;
And an E and a Y and an E spell I,
Pray what is a speller to do?
Then, if also an S and an I and a G
And an H E D spell side,
There's nothing much left for a speller to do
But to go commit siouxeyesighed.

Charles Follen Adams

Project USAP—Part III: Practice by heavy users of sedation in pediatric dentistry

Milton I. Houpt, DDS, PhD

Project USAP was initiated in 1985 in order to study the use of sedative agents in pediatric dentistry.[1] Part I of the project surveyed all members of the American Academy of Pediatric Dentistry in regard to their use of sedation; and Part II of the project examined the experiences that postdoctoral students have in their training programs. Part III of the project was performed in order to examine the use of drugs by heavy users of sedation in pediatric dentistry.

METHODS

Of the 1,105 participants in Part I of Project USAP, twenty-five volunteered to participate in the more extensive Part III of the project. These practitioners represented a group of heavy users of sedation who had sedated at least two patients each day, every day, over a period of three consecutive months. The practitioners were asked to gather data for thirty consecutive patients who were to be sedated for dental treatment (Figure). Behavioral ratings were recorded for crying and movement at the start of treatment and thereafter at fifteen-minute intervals. In addition an overall rating of behavior was recorded. Additional data were collected concerning the drugs used, the method for dosage calculation, the method for drug administration, the use of nitrous oxide, the use of physical restraints, and experience with any side effects.

At the start of the project, the participants were asked to complete one form and return it to the investigator to ensure correct use of the form. Following completion of the first form, an additional fourteen forms were sent to each practitioner for completion and return. After review of those forms, the final batch of fifteen forms were sent for completion. In general all practitioners provided excellent cooperation and the data were collected within a few months following initiation of the study.

RESULTS

The twenty-five practitioners submitted data forms for seven hundred and twenty-nine subjects. Most of the subjects were classified as medically normal with a mean age of fifty-eight months (range = 16 to 168 months) and a mean weight of forty-three pounds (range = 20 to 99 pounds). Although a variety of sedative agents were used by the different practitioners, most used one particular drug combination for example, meperidine/promethazine, or meperidine/chloral hydrate, or chloral hydrate/hydroxyzine. Two thirds of the drugs were administered orally with the remainder administered intramuscularly, intravenously, subcutaneously or rectally. A similar two thirds of the drugs were administered in the practitioner's office with the remainder being ad-

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The author wishes to express his appreciation to the twenty-five practitioners and their office staffs for their participation in this study. In particular, the author wishes to acknowledge the dedication of participants in accurately completing the survey forms.

PROJECT USAP--SEDATION EFFECT SURVEY

1. Date:_____ AM [ ] PM [ ] Patient I.D. Number:_____
2. Age:_____(Months) Weight:_____(Pounds) Medically Normal [ ] or Compromised [ ]
3. Drug(s) Used:_____ Dosage:_____(cc or mg)
4. _____ _____(cc or mg)
5. _____ _____(cc or mg)
6. How was dosage calculated? Weight [ ] Age [ ] Other [ ] How_____
7. Where was drug administered? Office [ ] Home [ ] Both Office and Home [ ]
8. How was drug administered? Oral (patient drank) [ ] Oral (forced by syringe) [ ]
   Intravenous [ ] Intramuscular [ ] Subcutaneous [ ] Rectal [ ]
9. Behavior in waiting room: Awake [ ] Asleep [ ] Crying [ ] No Crying [ ]
10. How long after drug administration did treatment begin? _____Minutes

---

11. RATING SCALE FOR CRYING

No Crying	- 4
Intermittent, mild	- 3
Continuous, strong	- 2
Hysterical	- 1

RATING OF BEHAVIOR DURING PROCEDURES

Mouth Prop	Injection	Rubber Dam	15 Mins.	30 Mins.	45 Mins.	60 Mins.	75 Mins.

12. RATING FOR MOVEMENT

No Movement	- 4
Movement not interfering with treatment	- 3
Movement making treatment difficult	- 2
Movement interrupting treatment	- 1

13. RATING FOR OVERALL BEHAVIOR DURING TREATMENT

No crying or movement	- 6
Some limited crying or movement (e.g. during anesthesia or mouth prop insertion)	- 5
Difficult but all treatment performed	- 4
Treatment interrupted, but eventually all completed	- 3
Treatment interrupted, only partially completed	- 2
No treatment rendered	- 1

[ ]

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14. Was nitrous oxide used? No [ ] Yes: 20% [ ] 30% [ ] 40% [ ] 50% [ ] 60% [ ]
15. Were there any physical restraints used? No [ ] Yes: Wrist Straps [ ] Pediwrap [ ]
    Papoose Board without Head Restraint [ ] Papoose Board with Head Restraint [ ]
    Other [ ] (Please Describe)_____
    _____
16. Were any side effects experienced? No [ ] Yes [ ] Please Describe_____
17. Behavior when child left office: Awake [ ] Asleep [ ] Crying [ ] No Crying [ ]
18. Additional Comments:_____

ministered to patients at home. Nitrous oxide was used for seventy-eight percent of the sedations, but restraints were used in only a third of the time. The sedative drugs usually provided excellent sedation with most subjects exhibiting little or no crying and little or no movement during most procedures. Ninety-six percent of the patients were awake when they left the office and only eleven percent were crying. The twenty-five practitioners reported an average of very good to excellent results of sedation for dental treatment. Only few side affects were experienced and these were reported for 4 percent of the sedations as nausea, vomiting, excessive sleep, or bizarre behavior.

DISCUSSION

Part III of Project USAP was performed in order to examine the results of sedations that were administered by heavy users of drugs in pediatric dentistry. In general, practitioners reported excellent results with their particular drug regimens with few side effects. This might be expected, as the participants in this study were experienced practitioners and had they had difficulty with a particular drug regimen, they might have been expected to have switched to a regimen that satisfied their treatment expectations. Although different drugs were used by different practitioners, in general a particular practitioner used a similar drug regimen for all of his or her patients who received sedation.

In pediatric dentistry patients are managed with both pharmacologic and nonpharmacologic methods. Whether or not drugs are used appears to depend on the biases of the practitioner, rather than the needs of the particular patient. Heavy users of sedation might argue that drugs are used to allay the fear or anxiety of the patient in order that treatment might be accomplished, and in order to have long lasting beneficial effects on the patient. Others might argue that the sedation procedure is not particularly pleasant, and sometimes even somewhat traumatic, producing long lasting, detrimental, psychologically traumatic effects. The long-term effects of dental treatment on infants or on young children with or without the use of drugs remains to be determined, and until that time practitioners rely on their preconceived opinions in regard to that question. Those who believe there are few if any long-term effects tend to be much more accepting of a crying child during treatment, and accepting of the use of restraints such as the Papoose Board® in order to enable treatment to be completed. On the other hand, those who are concerned about the potential of a long-term detrimental effect would be much more bothered by the use of restraints and the occurrence of crying that might signify discomfort experienced by the child. Such practitioners might even advocate the use of general anesthesia as an alternative to a child crying during treatment. Others view the general anesthetic procedure, however, as having a similar potential for producing long-term detrimental psychological effects. The question remains as to why some children would be sedated by some practitioners, but treated effectively without sedation by others.

Whether or not a child is sedated for dental treatment depends also on the disposition of the parent or guardian and the disposition of the practitioner. Some parents or guardians are more or less accepting of crying by the child during treatment, and this would influence their requests for treatment to be performed either with sedation or with general anesthesia. Depending on how the use of restraints is explained, some parents would find restraints barbaric, whereas others would understand the necessity similar to their use in other hospital procedures. The personality of the practitioner perhaps more than any other factor dictates the frequency of use of sedation. The strength of personality of the practitioner and his/her attitude toward use of sedation influence its success. That the vast majority of procedures are successful might be due to the effect of expectation and some patients might have been managed just as well with nonpharmacologic methods.

It appears from Project USAP that most patients who are sedated are managed well during dental treatment. It is unclear, however, whether similar success would be obtained in more difficult to manage patients. An important area of research to be performed is the study of the effects of variables in the personality of the practitioner on the behavior of the child. In addition there is a need for better methods to differentiate those patients requiring sedation from those who might be managed best with nonpharmacologic methods.

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Effectiveness and acceptance of electronic dental anesthesia by pediatric patients

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Donald F. Duperon, DDS, MSD

In the past decade interest has been renewed in dental applications of electronic pain control. Various electronic dental anesthesia machines are currently advertised in the dental products information periodicals. References to the use of electricity for dental pain control can be found in texts published in the 17th,18th and 19th centuries, while medical uses of electricity date back to the year 46 A.D.[1] Electroanalgesia in dentistry was popular up to the early 1900s, then interest subsided until the 1970s.

Transcutaneous electrical nerve stimulation (NS) was developed for dental use as a modification of TENS units, which were and are currently utilized for analgesia and stimulation in physical therapy. Electronic Dental Anesthesia (EDA) was developed more recently with features more suitable for dental treatment. All EDA units are classified as TENS units by the ADA Council on Dental Materials, Instruments and Equipment, although most EDA unit manufacturers differentiate their unit from TENS units.[2]

The mechanism for production of anesthesia/analgesia by TENS or EDA units is based on several theories on mechanisms of pain transmission. The gate control theory of Melzack and Wall theorizes stimulation of large, peripheral A-delta nerve fibers that close a spinal gate and prevent painful stimuli carried on the small C-fibers from gaining access to the ascending transmission system.[3] Another explanation for the effectiveness of TENS or EDA is that the electrical stimulation causes release of endorphins that attach to opiate receptors and block transmission of painful stimuli.[4] Beta-endorphins and enkephalins, which are potent analgesics, are also increased in the cerebral circulation during electrical stimulation.[5]

Another theory is that serotonin, dopamine, and norepinephrine are produced, which have roles in the effects of electrically-produced analgesia.[6] Serotonin's analgesic properties may elevate the pain reaction threshold.

The clinical uses of EDA for restorative dentistry, which have appeared in the literature, demonstrate various success rates. One study demonstrated an 80 percent success rate for restorative procedures.[7] Donaldson, Quarnstrom, and Jastak treated 124 adult patients, using a high-frequency (58Hz), low (23) voltage unit similar to EDA with nitrous-oxide/oxygen obtained an 81 percent success rate.[8] Their success rate with electronic anesthesia alone was only 33 percent and 36 percent with nitrous-oxide/oxygen alone. Hochman reported a 76 percent success rate for 473 mostly two- and three-surfaced restorations using a TENS unit.[9] Clark *et al* utilized a 15 Hz, 27 volt TENS unit with one pair of electrodes placed over the temporal area

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and another pair of electrodes attached intraorally, adjacent to the operative site, and another on the web of the hand of the ipsilateral side of treatment.[10] These investigators reported a 93 percent success rate for restorative procedures, while the placebo group in this doubleblind study reported a 43 percent success rate for similar procedures.

Other studies have demonstrated the effectiveness of TENS or EDA for scaling and curettage. Clark *et al* demonstrated 100 percent effectiveness for root planing, curettage, and subgingival scaling while Hochman demonstrated an 83 percent success rate.[9,10] Malamed demonstrated a 75 percent success rate for fixed prosthodontic procedures.[5]

Clark demonstrated no success with four attempts at endodontic procedures; he was successful, however, in two of four attempts at removal of nonimpacted teeth.[10]

Meizels demonstrated reduction of pain and return of more normal ranges of motion for patients with temporomandibular dysfunction with a TENS unit used with extraoral electrodes.[11] Another successful use of EDA was described for a patient with alleged local anesthetic allergies.[12] This patient was treated without injectable local anesthetics to manage operative discomfort.

One reference to treatment for children could be found as part of a larger study.[13] The authors utilized three different h-wave and square-wave TENS units in conjunction with four different nitrous oxide delivery systems and reported a 97 percent success rate for children thirteen years of age and younger.

The purpose of this clinical trial was to determine the efficiency and acceptance of EDA when utilized for pediatric patients.

MATERIALS AND METHODS

Forty patients from a private pediatric dental practice participated in this trial, ranging in age from three years, nine months to twelve years, participated (mean = 7.5 ± 2.64). None of the patients included had ever experienced EDA or TENS for any dental or medical treatment. All patients reported on were experiencing EDA for the first time and second EDA visits were not included in this study. All patients were American Society of Anesthesiology Class I or II and did not list any of the manufacturer's contraindications to EDA, or general contraindications to outpatient dental treatment in the written or verbal medical history reported by the patients' parents. No other adjuncts to anesthesia such as sedation, general anesthesia or nitrous-oxide/oxygen were utilized for treatment.

The EDA unit used in this study (UltraCalm™, Sion Technology, Aurora, Colorado) differs from conventional TENS units in that:

- ☐ EDA utilizes a low current with a maximum of 4 mA compared with 100 - 150 mA for TENS.
- ☐ EDA uses higher frequencies (15,000 cycles) than TENS devices (10-200 cycles).
- ☐ EDA is utilized for short treatment periods compared with longer treatment times for TENS.
- ☐ TENS units may burn tissues if adjusted incorrectly by the patient; EDA will not cause tissue damage.

Additionally, this type of EDA unit has a more comfortable wave-form than TENS, which means there is no irritating, pulsating feeling near the electrodes.

The UltraCalm™ EDA system utilizes low voltage (2.0 volts), high frequency wave form (15hz with 15Khz carrier) and maximum average power of 1740 microwatts. This system delivers power with 1 X 3 cm disposable adhesive electrodes, which are applied to the attached gingiva as illustrated in Figure 1. Current may be adjusted by the patient with a remote, hand-held unit. Figure 2 shows a patient holding the remote unit and the EDA unit on the bracket tray.

Procedures performed were amalgam restorations, posterior composites, preventive resin restorations, stainless steel crowns, and anterior composites and composite crowns. Many patients received multiple restorations or quadrant treatment. The rubber dam was utilized for all procedures except composite crowns. Treatment times ranged from ten to sixty minutes.

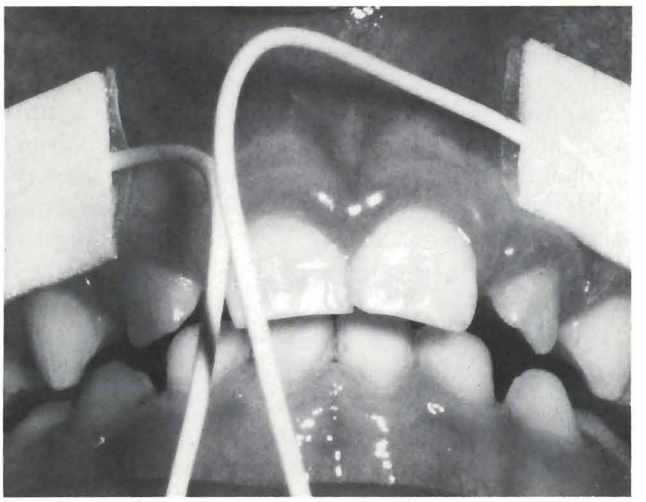

Figure 1. Disposable adhesive electrodes in place on attached gingiva.

Figure 2. Patient holding adjustable remote unit. The EDA unit is on the bracket tray.

Levels of anesthesia were maintained during procedures with 20 percent to 80 percent of maximum power with an average of 50-60 percent. Explanation of EDA and subjective sensations were adjusted for each patient's level of comprehension. Patients were instructed that at any time the procedure could be stopped and injectable local anesthetic could be administered.

All treatment and evaluation of anxiety and rapport was determined by one dentist. Approximately one-half of the forty patients (n = 19) had received local anesthetic by injection at previous visits; the remainder had never experienced local anesthesia. The patients who had not experienced injectable local anesthetic may have had other dental procedures performed previously, i.e., prophylaxis, fluoride treatments, radiographs.

Patient apprehension or anxiety was rated as low, average, or high by the dentist performing the treatment. Apprehension ratings were made by the appropriate or inappropriate movements, verbal comfort or discomfort, and/or nonverbal comfort or discomfort which the patient demonstrated before and during the anesthesia/treatment. Patients for whom nitrous-oxide/oxygen, sedation or general anesthesia was considered were not considered for treatment with EDA.

Patients rated "low" anxiety usually listened to explanations, asked questions, did not retreat from dental personnel or interrupt delivery of anesthesia or treatment.

Patients rated "average" usually expressed any reservations they may have had about anesthetic or treatment, asked questions that demonstrated concern or anxiety about their well-being, acted very interested or suspicious about equipment and movements toward them. These patients were likely to interrupt delivery of anesthetic or treatment at least once during the procedure by asking questions or interrupting treatment to tell the dentist or assistant something peripheral to the procedure to delay or "stall" treatment.

Patients rated "high" for anxiety expressed inappropriate movements, verbal discomfort, and/or nonverbal discomfort. These patients were most likely to talk about their concerns for an inappropriate length of time or ask questions that delayed anesthesia or treatment. They may have also tried to delay or "stall" by inappropriate body movements: retreating from dental personnel, raising their hands over their faces, facial grimaces to nonthreatening procedures, or requests to repeat explanations of procedures.

Patient-dentist rapport was rated as poor, average, or good by the same dentist. Rapport was operationally defined as the ability to establish a relationship with the patient, i.e., the dentist could maintain eye contact, physical contact, and elicit verbal responses from the patient. Often age-dependent, this rating was probably the most subjective assignment and was based on clinical experience.

As stated previously, the unit utilized in this study allowed EDA current to be adjusted by the patient with a remote, hand-held unit. The current level was initially adjusted by the dentist until the patient said she could feel initial symptoms and was recorded. After approximately four minutes, most patients could feel a decrease in initial symptoms and adjusted current with the remote, hand-held unit. This level was recorded as START TX. EDA levels were also recorded as TREATMENT after treatment had started, usually after one minute or when sound dentin was reached. EDA levels were also recorded at the end of treatment. The difference between EDA levels at the start of treatment (just before actual treatment) and after one minute, or when sound dentin was reached, was calculated as EDA COMPENSATION (Table 1). EDA compensation was the amount of current necessary for the pa-

Table 1 ☐ EDA levels at different periods during anesthesia.

	Mean	S.D.	Range
Intial sensation	4.47	1.33	1.9 - 6
Start TX	4.62	1.43	2.1 - 8
EDA comp (Start - TX)	1.02	1.41	-.5 - 4.7
TX	5.64	1.27	2.2 - 8
End of TX	5.15	1.31	2.2 - 7.1

tient to adjust levels of current for their own comfort and was utilized for comparisons and possible relationships between age, gender, previous injectable local anesthesia experience, anxiety, rapport, appointment length, and reported discomfort.

For some patients who were not cooperative due to age, anxiety, poor rapport, cooperation or combination, the dentist administering treatment adjusted EDA levels for the patient. The level was usually set to an arbitrary level of "6", which was suggested by the distributor of the EDA device.

Treatment times and patient preference for future use of EDA were also recorded. The patients' report of discomfort was recorded as none, slight, moderate, or severe.

RESULTS

EDA Levels

The current level was initially adjusted by the dentist until the patient felt initial symptoms. After approximately four minutes, most patients could feel a decrease in initial symptoms and adjusted current with the remote, hand-held unit. This level was START TX. EDA levels were also recorded as TREATMENT after treatment had started, usually after one minute or when sound dentin was reached (Table 1). The difference between EDA levels at the start of treatment and after one minute, or when sound dentin was reached was EDA COMPENSATION and represented the amount of current increase (or on one case, a decrease) necessary to perform treatment.

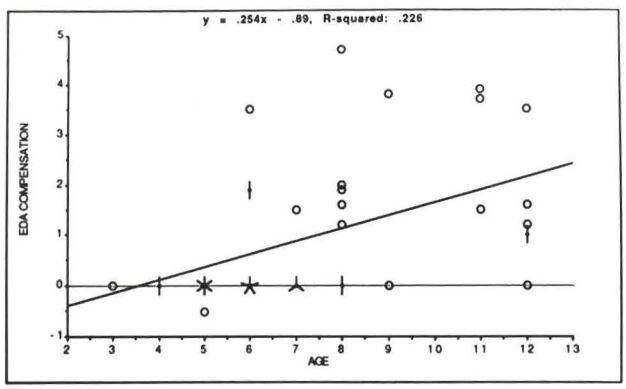

Figure 3. Scattergram displaying age versus EDA compensation. Single occurrences are displayed as a circle; multiple occurrences are displayed by lines emanating from points.

Age

The mean age for all forty patients was 7.5 ± 2.64 years with a range of three to twelve years. No relationships were noted between age and EDA compensation. Figure 3 displays EDA compensation vs age. Many of the younger patients show no increase in EDA compensation. Some of these patients had EDA levels set for them and did not increase levels, although they had the opportunity to do so.

Gender

Eighteen males and twenty-two females were included in the clinical trial. The males average EDA compensation was 0.96 ± 1.43 with a range of 0 to 3.9. Females averaged 1.08 ± 1.43 with a range of -0.5 to 4.7. T-tests revealed no significant differences between genders.

Previous local anesthesia experience

Twenty-one patients had experienced injectable local anesthesia for operative or other dental procedures, while nineteen patients had never experienced any type of local anesthesia. Table 2 shows means, standard deviations and ranges of EDA compensation for the two groups. Mean EDA compensation levels differed, i.e., 1.59 for the experienced group vs 0.40 for the nonexperienced group and a t-test between the groups revealed a significant difference between the groups ($t = -3.152$, $p < .01$).

Patient anxiety

Figure 2 displays EDA compensation vs patient anxiety. Regression analysis demonstrated no tendencies for apprehensive patients to require more EDA compensation.

Table 2 ☐ Comparison of patients with previous local anesthesia experience and without local anesthesia experience. Patients without previous local anesthesia experience increased EDA levels significantly less than experienced patients.

	N	Mean EDA comp	S.D.	Range
Experienced	21	1.59	1.63	0-4.7
No local anesthetic experience	19	0.40	0.76	-.5-1.9

Patient-dentist rapport

Figure 5 displays EDA compensation vs patient-dentist rapport. Regression analysis revealed a trend for anxious patients to require more EDA compensation; no significant trends, however, can be demonstrated.

Treatment time

The length of appointment vs EDA compensation was also plotted and displayed in Figure 6. EDA compensation was not related to appointment length, nor was end of treatment EDA level related to appointment length.

Reported discomfort

Patients reported discomfort during treatment or after treatment was completed and care was taken not to lead patients into an answer by asking, "How does this (handpiece) feel?" Patients were grouped into *no discomfort, slight, moderate,* or *severe discomfort* groups.

Patients who reported some discomfort could not distinguish whether the origin was from the dental procedure or from the EDA current. Two patients reported moderate discomfort (Figure 7). The two who reported moderate discomfort were injected with local anesthetic to complete treatment. These two patients also reported discomfort from the procedure after local anesthesia. It is interesting that even with injectable local anesthetic, discomfort was not entirely eliminated. Perhaps the discomfort was related more to a lack of desire to cooperate. Most reports of slight discomfort were vague, nonquantifiable statements consisting of "...it feels funny," or "...I can't describe it, but I can feel the scratcher (handpiece)." None of the patients reported severe discomfort.

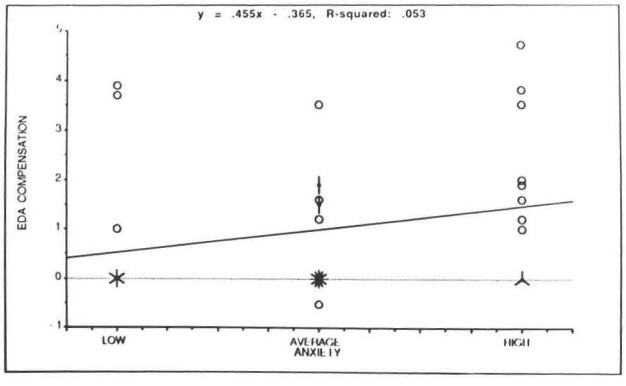

Figure 4. Patient anxiety expressed as low, average *or* high *compared with EDA compensation. EDA compensation was the amount of current necessary for the patient to adjust levels of current for her own comfort.*

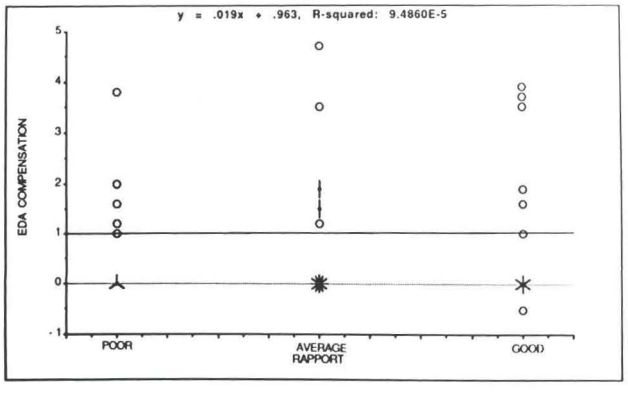

Figure 5. Patient-dentist rapport compared with EDA compensation. No relationship could be demonstrated.

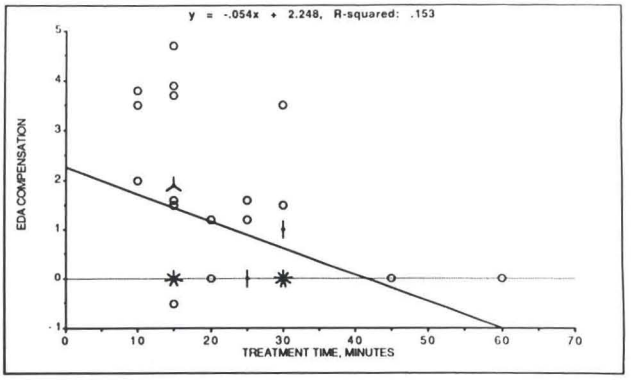

Figure 6. Treatment time compared with EDA compensation. No significant comparison could be demonstrated.

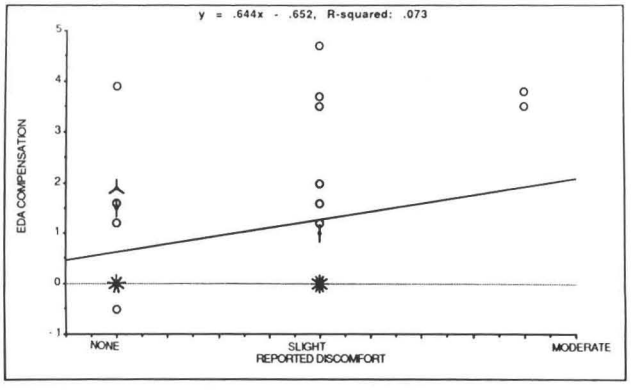

Figure 7. Reported patient discomfort compared with EDA compensation. Patients who reported no discomfort required less EDA adjustment.

Preference for future treatment

All patients who had experienced local anesthesia for dental treatment preferred EDA to injectable local anesthetic. Since the nonexperienced group had no reference for comparison, a strong statement could not be made for EDA's preference. Also because the nonexperienced group tended to be younger than the experienced group, their vocabulary, past experiences and level of comprehension did not allow them to endorse strongly or make subjective comparisons.

DISCUSSION

EDA compensation was chosen as an independent measure of anesthesia, as this was the current adjusted by the patient for her own comfort. This variable was measured as the difference between EDA levels at the start of treatment (just before actual treatment) and after one minute or when sound dentin was reached (Table 1). No significant differences were demonstrated when comparing EDA compensation with age or gender. While some of the younger patients had EDA levels adjusted for them, all patients had the opportunity to raise or lower EDA levels with the handheld remote unit.

Patients who had experienced injectable local anesthetic used more current for anesthesia. Levels for the experienced group were three times greater and differed significantly from nonexperienced children who had never experienced injectable local anesthetic. This may be explained by the fact that children who had previously experienced injectable local anesthesia may have expected more symptoms from the anesthetic itself, such as numbness or tingling sensations. These children may have felt more comfortable feeling the subjective sensations from higher EDA current levels as the treatment was initiated.

No other trends were demonstrated that related EDA compensation with patient apprehension, patient-dentist rapport, treatment time, or patient discomfort. While all of these patient characteristics were subjective, they were assigned by one dentist, who utilized behavioral measurements for the assignment.

Few patients reported discomfort during treatment or after treatment was completed. The patients who reported or were grouped as "slight" discomfort reported "funny feelings" or a low level of discomfort that did not interfere with treatment. None of the patients who participated in this study reported severe discomfort and the two patients who reported moderate discomfort were completed using local anesthesia. Even with injectable local anesthetic, discomfort was not entirely eliminated and the same two patients also reported discomfort from the procedure after local anesthesia.

As mentioned before, all patients who had experienced local anesthesia for dental treatment preferred EDA to injectable local anesthetic solutions. Since the nonexperienced group was younger and had no reference for comparison, a strong statement could not be made for EDA preference.

EDA may offer many safety and psychological advantages over local anesthesia, using a local anesthetic. EDA is not a drug, so the lowest possible doses for clinical efficiency are a consideration; safety is not compromised, however, even when utilizing maximum levels of current. Toxicity and sensitivity reactions to local anesthetic solutions are eliminated and there is no possibility of intravascular injection or reactions to local anesthetic solutions or preservatives. Since the pro-

Patients who experienced EDA and local anesthesia by injection preferred EDA.

cedure is noninvasive, discomfort from an injection, psychological objections, and needle phobias are eliminated. Multiple quadrants can be treated without multiple injections and there is no possibility of infection at the injection site.

One of the greatest postanesthesia problems for pediatric patients has always been self-inflicted trauma from chewing soft tissues. EDA symptoms are eliminated as soon as the current is turned off, although circulating endorphins and serotonin may persist. Since the patient completes treatment without a numb tongue, cheek or lips, inadvertent soft tissue trauma is eliminated and the patient can eat, drink, or speak without lingering impairment from the local anesthesia.

Another injectable local anesthetic problem, eliminated with the use of EDA, is that with the cessation of EDA, the patient's tactile senses are not altered by numbness and occlusal adjustment of new restorations may be more accurate.

A possible benefit of EDA is the control over anesthesia the patient feels when she is able to adjust the level of anesthesia with the hand-held, remote unit. Allowing the patient to control a portion of the treatment may be a significant psychological adjunct.

CONCLUSIONS

- ☐ EDA was effective for 95 percent of patients receiving restorative care.
- ☐ Young patients accepted EDA and preferred it to injectable local anesthetic.
- ☐ EDA may offer many safety and psychological advantages over injectable local anesthetics.

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INFLUENCE OF THUMB SUCKING ON PEER SOCIAL ACCEPTANCE

The results of this study suggest that first-grade children find their thumb-sucking peers less acceptable than their non-sucking peers. Forty first-grade children rated slides of thumb-sucking peers significantly and substantially less favorably than slides of the same peers not sucking their thumbs. While in the thumb-sucking pose, the peer was rated as significantly less intelligent, happy, attractive, likable, and fun and less desirable as a friend, seatmate, classmate, playmate, and neighbor than when they were in the non-thumb-sucking pose. The significant factors in the three-way interaction (sex of rater and pose of the child in the slide) suggest that gender influenced ratings. That is, boys and girls rated their same-sex peers as more acceptable than opposite-sex peers, which is consistent with the well-established finding that young school-age children prefer same-sex peers. The analysis did not yield significant differences between peer ratings of thumb-sucking boys and girls: first graders rate both boy and girl thumb suckers negatively.

Friman, P.C., *et al*: Influence of thumb sucking on peer social acceptance in first grade children.
Pediatrics, 91:784-786, April 1993.

SEALANTS

Effects of delegation, state practice acts, and practice management techniques upon sealant utilization: A national survey of pediatric dentists

Frank J. Foreman, DDS, Lt Col, USAF

Pit and fissure sealants are a highly effective, safe, cost-effective, but greatly underutilized means of caries prevention.[1-4] In 1971 the American Dental Association first recognized sealants as safe and effective.[5] Within ten years of that statement, the ADA organized a symposium concerning the underutilization of sealants by the dental profession.[6] In 1984 the National Institutes of Health also concluded a symposium on sealants by emphasizing their underutilization and recommending additional research to ascertain the reasons for this underutilization.[7] Following this recommendation and the example of Gift, much research was done using surveys to document the attitudes of pediatric dentists and general dentists toward sealant utilization.[8-16] Most of these surveys primarily examined attitudes toward sealants. Practice management techniques that influenced sealant utilization were generally of secondary interest. The practice management variable most often examined in the surveys was the delegation of sealants to auxiliaries.

In order to increase cost effectiveness, the ADA and the NIH noted that sealants could and should be delegated to dental auxiliaries.[6,7] Both also recommended that state practice acts be changed to allow such delegation. In response to these recommendations widespread changes in state laws have occurred in the last decade. According to ADA surveys concerning legal provisions for delegating functions to dental assistants and hygienists, in 1981 only twelve states allowed the placement of sealants to be delegated to assistants, while thirty states allowed delegation to hygienists. By 1990 the number of states allowing delegation to hygienists increased to forty-nine. Delegation to assistants, however, increased to only twenty states. Two of the survey studies examined the respondents' perception of their state practice acts concerning sealant delegation in relation to utilization.[12,13]

The latest ADA statement concerning sealants in 1987 again emphasized their underutilization.[2] It referred to the then recently released NIDR study concluding that only 7.6 percent of American school children had received sealants. This NIDR study also found a great regional variation in sealant utilization.[4]

The purpose of the present study is to determine, not the attitudes, but the practice management variables, that influence sealant utilization among pediatric dentists nationally.

METHODS AND MATERIALS

Between January 1 and June 10, 1991, 400 fifteen-question surveys were mailed to members of the American Academy of Pediatric Dentistry in private practice in all fifty states and the District of Columbia. The members were selected randomly, but an attempt was made to balance the surveys on the following bases:

- ☐ *Geographically* Proportional to these geographic regions' populations as described in the US 1990 census.
- ☐ *Sealant Prevalence Areas* The results of the NIDR survey in 1987 indicated relatively high sealant utilization in Regions I, V, and VI (12-13 percent), medium utilization in Region VII (9 percent), and low utilization in Regions II, III, and IV (5-6 percent).[4] The surveys were mailed proportionally to the populations of these three areas.
- ☐ *State Practice Acts* Within the geographical regions and the sealant prevalence areas, the populations of the states that allow sealant delegation only to dental hygienists and those that allow it to both dental hygienists and assistants were calculated. The status of the practice acts was ascertained from the April 1991 ADA survey and from local contacts. The surveys were mailed proportionally so that the ratio between the states' practice acts and the populations approximately represented the regions and areas.

It was not possible to maintain the surveys completely proportional in all three of these variables. Where differences arose, the differences in percentages were split.

- ☐ *Board Certification* Approximately one third of the surveys were sent to Board Certified diplomates in the American Academy of Pediatric Dentistry. This overrepresented the proportion of diplomates, which is approximately 25 percent of the membership who are not students or retired.

The survey was designed so that most questions could be completed by circling one answer on a six-point ordinal scale. The survey also included several opinion questions concerning the risks of sealants, injuries resulting from sealant placement, and knowledge of the respondent's state practice act concerning sealant delegation. The answers to the ordinal questions were converted into numbers from one to six and examined. Correlations were calculated between these ordinal variables and between the demographic categorical variables of the respondents.

RESULTS

Of the 400 surveys mailed, 265 were completed and returned, for a return rate of 66.3 percent. From the fifteen questions on the survey and the data available concerning the respondents, twenty-one variables were examined. The variables were either categorical or ordinal in nature. The variables were divided into three groups: five primary variables (Table 1), nine management variables (Table 2), and seven practice variables (Table 3). The primary variables represent those variables that are most significant to sealant utilization. The management variables concern practices that are under the control of the dentist. The practice variables concern the demographics of the practices which are, for the most part, not under the control of the dentist.

Two of the primary variables were calculated from the survey data. Access was determined by dividing the estimated number of examinations and recalls completed per day by the estimated number of sealant patients seen per day. Efficiency was determined by examining access only in larger practices (those completing sixteen or more examinations or recalls per day).

In order to examine the effect of delegation more closely, a categorical management variable was calculated. The variable of delegation pattern was obtained by placing each practice into the categories of either:

- ☐ DR: Over 75 percent of the sealants were placed by the doctor.
- ☐ DH: Over 75 percent of the sealants were placed by a hygienist.
- ☐ DA: Over 75 percent of the sealants were placed by an assistant.
- ☐ MIX: No one provider type placed over 75 percent of the sealants.

The practice variable for sealant prevalence area was taken to be ordinal: with those in the high prevalence area measured at 12 percent, those in medium area at 9 percent, and in the low area at 6 percent.

After examining the ordinal variable of years of experience in practice, the results were found not to be normal. The very new practices had more factors in common with the older practices than with those in the middle. On this basis the experience variable was converted to a categorical variable and examined as such.

The categorical variables were compared to one another using contingency tables and the Pearson Chi Square statistics. The relationships between the categorical and ordinal variables were examined using the Kruskal-Wallis test to compare the mean ranks across categories. The relationships between the ordinal variables themselves were examined, using the Spearman Rank Order Correlation Coefficients.

Primary variables

Table 1 defines the five primary variables, gives their ordinal and extrapolated results, and significant correlations.

Table 1 ☐ Primary variables with their significant correlations.

	Extrapolated result	Ordinal mean (SD)	N	Significant correlations
Quantity - sealant patients per day	4	3.4 (1.2)	259	Access = +.001*, Efficiency = +.001*, .001*, Retention = −.03* Practice size = +.001*, Delegation = .001** (DEL>DR) Doctor = −.001*, Hygiene = +.001*, Assistant = +.03* Indication = +.001*
Access - % of exam and recall patients receiving sealants	28%	3.3 (1.5)	258	Quantity = +.001*, Cost = −.04*, Retention = −.03* Efficiency = +.001*, Practice size = −.001* Prevalence Area = +.04*, Indication = +.01*
Efficiency - access in practices with > 16 exams or recall patients per day	23%	2.8 (1.1)	159	Quantity = +.001*, Access = +.001* Delegation = +.05** (MIX>DH/DA>DR), Indication = +.001* Doctor = −.003*, Hygienist = +.01*, Prevalence area = +.04*
Cost - as % of single surface restoration	48%	3.4 (0.7)	258	Access = −.04*, Delegation = .04**(MIX>DA>DH/DR) Indication = −.04*, Rubber dam = +.001*, Cotton rolls = −.001*, Diplomate = +.001** Practice size = +.03*, Region = .02** (NE/W>MW/S)
Retention - average of estimated retention after 1, 2, and 3 years	85%	3.0 (.09)	265	Quantity = −.03*, Access = −.05* Cotton rolls = +.02*

* Spearman Rank Order Correlation
** Krusal-Wallis Test

Among the significant findings listed, it is of note that:

- ☐ The quantity of sealants placed is positively correlated with delegation and negatively correlated with placement by a dentist. It is also of note that no correlation was found between quantity and sealant prevalence area, state practice act, insurance coverage, years of experience, and the fluoride status of the practice.
- ☐ Access to sealants, although positively correlated with quantity, was negatively correlated with practice size. In larger practices, more sealants were placed, but a smaller percentage of patients examined were sealed. Of note is that no correlation was found between access and delegation pattern or state practice acts.
- ☐ Efficiency in maintaining access to sealant care in large practices, however, was found to be correlated with delegation pattern, especially with hygienists. It was negatively correlated, however, with sealant placement by doctors. No correlations were noted between efficiency and methods of isolations or size of practice beyond sixteen exams or recalls per day.
- ☐ The cost of sealants, relative to single surface restorations, was found to be positively correlated with delegation and negatively correlated with high access, perceived indication, and cotton roll isolation. No correlations were noted between cost and quantity, efficiency, or insurance.
- ☐ The estimated retention rate after two years of the sealants placed in a practice was found to be positively correlated only with cotton roll isolation. It was negatively correlated with both the quantity and access of sealant utilization. Those who placed more sealants estimated, therefore, less retention. No correlations were noted between retention and delegation, efficiency, indication, or any other isolation variable besides cotton roll isolation (which was perceived superior).

Management variables

Table 2 defines the nine management variables, gives their ordinal and extrapolated results, and significant correlations.

Among the significant findings it is of note that:

- ☐ Sealant placement by the dentist was found to be negatively correlated with the quantity and efficiency of sealant placement, delegation of sealants to auxiliaries, and practice size. It was positively correlated with regional and state practice acts that excluded assistants.
- ☐ Sealant placement by a hygienist was positively correlated with quantity and efficiency of sealant placement, practice size, and use of cotton roll isolation. It was negatively correlated with dentist and assistant placement and rubber dam usage.
- ☐ Sealant placement by an assistant was positively correlated with quantity of sealants placed and rubber dam usage, but negatively correlated with dentist and hygienist placement, providing the

Table 2 ☐ Management variables with their significant correlations.

	Results		N	Significant Correlations
Delegation pattern- >75% of sealants by DR, DH, DA, or mixed	DR= 50.0% (100% DR=38.6%) DH = 9.3% DA= 17.9% MIX= 22.8%		246	Quantity =.004**(Del>DR), Efficiency =.05** (MIX>DH/DA>DR), Cost = .04**(Mix>DA/DH>DR), Practice act=.001**, Practice size =.001** (DH>MIX/DA>DR), Region =.001***(Fig. 2), Indication =.05**(DA>DH>MIX>DR)
	Extrap-olated Results	Ordinal Mean (SD)		
Doctor - % of sealants placed by dentists	63%	4.0 (1.9)	248	Quantity = −.001*, Efficiency = −.003*, Practice act =.001**DH>DA), Practice Size = −.001* Hygienist =.001*, Assistant = −.001*, Indication = −.005*, Four handed = +.005*, Region =.02**(MW>NE>W>S)
Hygienist - % of sealants placed by hygienists	10%	1.9 (1.4)	247	Quantity = +.001*, Efficiency = +.01*, Doctor = −.001*, Assistant = −.01*, Practice act =.003**(DH>DA), Practice size= +.002* Rubber dam = −.01*, Cotton roll = +.04* Region =.02**(NE/S>MW>W)
Assistant - % of sealants placed by assistants	13%	2.0 (1.6)	247	Quantity = +.03*, Indication= +.04*, Doctor = −.001*, Hygienist = −.01*, Rubber dam = +.02*, Cotton roll = −.01* Four handed = −.004*
Indication - % of newly erupted molars indicated for sealants	85%	4.9 (1.1)	264	Quantity = +001*, Access = +.01*, Efficiency = +.001* Cost = −.04*, Delegation =.05**(DA>DH>MIX>DR), Doctor = −.005*, Assistant = +.04*
Time - # minutes allotted for average sealant patient	26	2.1 (1.1)	265	Rubber dam = +.007* Cotton rolls = −.006*
Four handed - % of time delegate seals with an assistant	35%	2.9 (1.6)	150	Doctor = +.005*, Assistant = −.004*, Practice size = +.05*, Fluoride = +.02*, Region =.03**(MW/NE>S>W)
Rubber dam - % of time delegate used rubber dam	20%	2.3 (1.6)	152	Cost = +.001*, Hygienist = −.01*, Assistant = +.02* Time = +.007*, Cotton rolls = −.001*
Cotton rolls - % of time delegate used cotton roll isolation	78%	4.6 (1.7)	152	Cost =.001*, Retention = +.02*, Time = −.006*, Hygienist = +.04*, Assistant = −.01*, Rubber dam = −.001*

* Spearman Rank Order Correlation
** Krusal-Wallis Test
*** Pearson Chi Square Statistics

auxiliary with an assistant, and cotton roll isolation.

Analysis of these results indicates that sealant placement tends to be concentrated on a single provider type (ie. that delegation tends to be either/or and rarely mixed). Also that access is not correlated with delegation, but efficiency is so correlated. Practice size is correlated with delegation, so that in smaller practices, access is maintained without delegation, while in larger practices access is maintained efficiently by delegation.

☐ Rubber dam isolation was positively correlated with the cost of sealants, the time allotted, and placement by assistants. It was negatively correlated with cotton roll isolation and hygienist placement. The results indicate that when pediatric dentists delegate sealant placement to a hygienist, they tend to allow cotton roll isolation, with less time scheduled and an assistant provided when practice size allows. When delegated to assistants, they tend to give more time for rubber dam isolation, but rarely provide a second assistant.

☐ The dentist's perception of the percentage of newly erupted molars indicated for sealants was positively correlated with quantity, access, efficiency, and delegation pattern, especially to an assistant. It was negatively correlated with cost and sealant placement by the dentist. Those who perceived a greater need for sealants, delegated, therefore, more and charged less.

Practice variables

Table 3 defines the seven practice variables, gives their ordinal and extrapolated results, and significant correlations. Within the geographic regions and the NIDR sealant prevalence areas the surveys were proportional to the actual populations within a mean of 2.1 percent and 11.3 percent, respectively. The ratios of the State

Table 3 ☐ Practice variables with their significant correlations.

	Results	Actual %	N	Significant Correlations
State practice act - allows only hygienists or both hygienists & assistants to place sealants	DH = 53.4% DA = 45.8%	52.2% 47.5%	264	Delegation = .001***(Fig. 1), Doctor = .001**(DH > DA), Hygienist = .003**(DH > DA), Assistant = .001**(DA > DH), Fluoride = .001** (DH > DA), Region = .001***(Fig. 2)
Region - geographical discription according to the 1990 US Census	MW = 23.9% NE = 19.7% S = 31.1% W = 25.4%	24.0% 20.4% 34.3% 21.2%	264	Cost = .04**(NE/W > MW/S), DR = .02** (MW > NE > W > S), DH = .02**(NE/S > MW > W), DA = .02**(S/W > MW > NE), Delegation = .001***(Fig. 2, MIX = NE > S > MW > W), Practice act = .001***(DA = W > MW/S > NE), Prevalence area = .001**(W > NE > S > MW), Fluoride = .001**(MW/NE > S > W), Four handed = .03**(MW > NE/S > W)
	Extrapolated results	Ordinal mean (SD)	N	
Prevalence area - high, medium, and low sealant prevalence area according to NIDR (1987)	8.7%	2.9 (0.9)	264	Access = + .04*, Efficiency = + .04*, Fluoride = − .001*, Region = .001**(W > NE > S > MW)
Practice size - # of exams and recalls per day	18	4.0 (1.6)	263	Quantity = + .001*, Access = − .001*, Cost = + .03*, Delegation = .001**(DH > DA/MIX > DR), Doctor = − .001*, Hygienist = + .002*, Assistant = + .01, Four hand = + .05*
Experience - years in practice	13.3		265	Practice size = .001**(10-25 yrs > 0-9 & over 25 yrs), Boarded = .001***
Insurance - % of patients with sealants covered at least half	30%	2.7 (1.2)	246	None
Fluoride - % of patients receiving optimal fluoride (communal or supplements)	83%	4.8 (1.2)	264	Practice act = .001**(DH > DA), Region = .001** (MW/NE > S > W), Prevalence area = − .001*

* Spearman Rank Order Correlation
** Krusal-Wallis Test
*** Pearson Chi Square Statistics

Practice Acts were proportional to the actual populations within a mean of 4.5 percent and 12.4 percent, for the geographic regions and prevalence areas, respectively.

Among the significant findings listed, it is of note that:

☐ State Practice Acts concerning sealant delegation were positively correlated with all delegating variables. Figure 1 illustrates this effect. Where delegating to both hygienists and assistants was allowed, 33.0 percent of the pediatric dentists chose to delegate over 75 percent of their sealants to assistants, while only 6.4 percent delegated to hygienists, and 42.2 percent chose not to delegate significantly. Where delegating to only hygienists was allowed, only 11.9 percent delegated over 75 percent of their sealants to hygienists, while 5.2 percent delegated to assistants (contrary to their practice act), and 56.0 percent chose not to delegate significantly. The net effect of excluding assistants from sealant placement was to decrease delegation by 22.3 percent and legal delegation by 27.5 percent.

☐ Years of experience, insurance coverage, and fluoride status were not found to be correlated with any primary variables.

☐ Regional differences in delegation patterns are illustrated in Figure 2. The Northeast has the lowest percentage of population that allows delegation of sealants to assistants. Relative to other regions, however, more pediatric dentists took advantage of delegating to hygienists. The Midwest has a relatively high percentage of its population allowing delegation to assistants; but relative to other regions, chooses to delegate less. The South is relatively limited in the percentage of its population allowing delegation to assistants; but chooses to delegate more than any other region to both hygienists and assistants. The West allows more delegation to assistants than any other region, but chooses to delegate less than is allowed.

☐ The finding of the NIDR survey in 1987 of high sealant prevalence in certain areas was not found to correlate with high quantities of sealants placed by pediatric dentists. It was correlated, however, with high access and efficiency of sealant place-

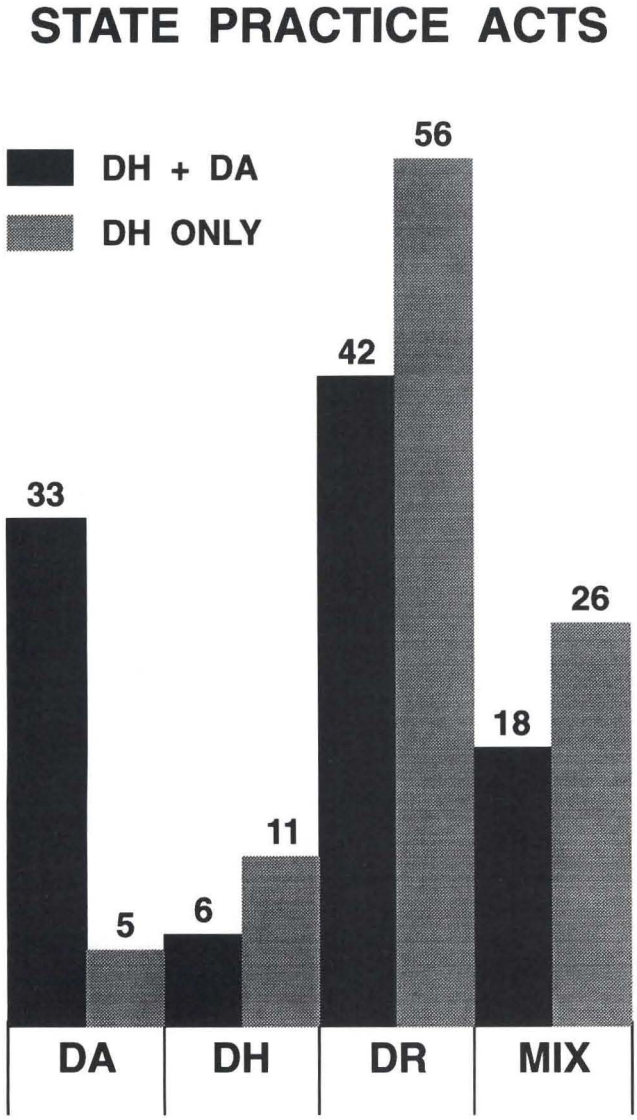

Figure 1. Percentages of practices in which over 75 percent of the sealants are placed by assistants (DA), hygienists (DH), doctors (DR), or a combination (MIX) as related to state practice acts concerning sealant delegation.

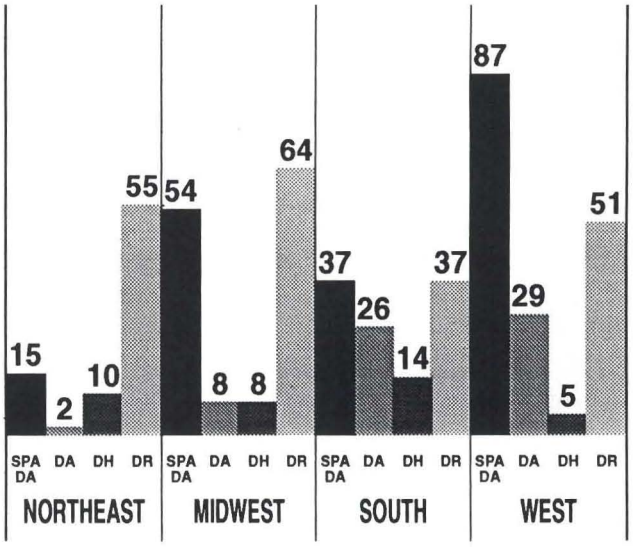

Figure 2. Regional variation relating state practice acts to delegation patterns; SPA DA = percentage of regional population where state practice acts allow sealant delegation to assistants, DA, DH, and DR = percentage of practices in which over 75 percent of the sealants are placed by assistants, hygienists, and doctors, respectively.

ment and to low fluoride availability. Fluoride tended to be more often optimal in the Northeast and Midwest. These were also the regions that dominated the NIDR's low sealant prevalence area and tended to have state practice acts delegating only to hygienists.

Opinion questions

One question was asked concerning the pediatric dentist's knowledge of his State Practice Act concerning delegation of sealant placement. Of the 241 who answered the question, only 69.7 percent were correct, 10.4 percent were unsure, and 19.9 percent were incorrect. Of those that were incorrect or unsure concerning their State Practice Acts, 74 percent did not delegate.

Questions were also asked concerning the perceived risks of sealant placement and injuries noted during placement. Of the 262 respondents 43.6 percent indicated no risk to sealant placement, 51.9 percent very slight risk, 4.2 percent slight, and 0 percent moderate or significant risk. In the opinion of 47.7 percent there was less risk in sealant placement than in a tray application of 1.23 percent acidulated phosphofluoride. While 40.7 percent thought the risks were comparable, only 12.6 percent thought the risks of sealant placement were greater.

One hundred and ninety-four of the 265 respondents (73.2 percent) reported no injuries noted during sealant placement. The vast majority of the reported injuries were very minor with the majority due to isolation techniques. Of these isolation injuries 71.4 percent were due to rubber dam clamp placement. The significant injuries included two cuspal fractures from the rubber dam clamps and a case of subcutaneous emphysema related to compressed air entering the submandibular space through the gingival sulcus in a partially erupted

mandibular molar. Mild discomfort was reported in the case of subcutaneous emphysema. Penicillin was prescribed and the emphysema resolved in a few days. There was one questionable allergic reaction to the sealant material that proved negative upon patch testing.

DISCUSSION

Successful sealant placement by dental hygienists and assistants is well documented, especially in Public Health programs.[17-19] Also, successful sealant placement has been well documented utilizing differing isolation techniques.[20-23] The management choice of whether to delegate sealant placement and how to require the auxiliary to maintain isolation is dependent upon many factors, including the state laws concerning delegation, the structure and size of the practice, and the individual dentist's biases. Due to the advanced training of pediatric dentists and the devotion of their practices solely to children, one would expect differences in practice patterns and biases between them and general dentists. This too has been noted in past studies.[11-15]

Among the pediatric dentists responding to this national survey, certain variables were found to have significant effects upon their sealant utilization. Rapid changes in state practice acts are reflected in the pediatric dentists' uncertainty and misunderstanding of their present state laws and put into question results dependent upon the doctors' knowledge of their state practice acts.[12,13] Those who were uncertain concerning the legality of delegating tended to not delegate. The flexibility of the pediatric dentist's state practice acts did significantly affect their delegation pattern. Either because of the expense or the shortage of dental hygienists, if delegation was allowed to both, over five times the number of doctors choose to delegate to assistants, rather than to hygienists. In contrasting those states that allow delegation to assistants with those that do not, over three times the number of pediatric dentists delegated to assistants as to hygienists.

The delegation pattern of the practices was positively correlated with the quantity of sealants placed and the efficiency of their placement in large practices. It was not related, however, to the access to sealant care. Apparently in small practices, sealant access can be maintained with the dentist placing the sealants. As the size of the practice increases, however, it becomes necessary to delegate the task in order to maintain that access efficiently. This is not an inexpensive, logistical step and, contrary to expectations, actually increases the cost of sealant placement.[3,7] What is not effected, as would be expected, is the perceived retention rates. It should be emphasized that the retention rates examined in this study are only the estimates of the practicing dentist and not longitudinally derived data. Sealants placed by auxiliaries have been shown, however, to have identical retention rates to those placed by doctors.[17-21] Also, the safety of delegating sealants to auxiliaries is confirmed to be beyond doubt.[6,7] At four patients per day, these 265 pediatric dentists treat approximately 250,000 sealant patients per year. The perceived risks and injuries reported are very slight indeed. Questions of whether to allow delegation of sealant placement to assistants need not include concerns of risks to the patients.

Over three quarters of the sealants placed were with cotton roll isolation. This form of isolation was found to take less time, reduce the cost of the sealants, cause significantly less trauma to the teeth and tissue, and was surprisingly perceived to be related to higher retention rates. Rubber dam isolation has never been shown to be correlated with higher sealant retention rates.[22,24] It seems that the tendency among pediatric dentists, however, when delegating sealants to assistants, is to require them to use a rubber dam, not to provide them with a second assistant, but to give them more time. Ironically, the procedure that caused the majority of injuries in sealant placement, the placement of the rubber dam clamp, was more readily delegated to assistants. Hygienists are apparently trusted to use cotton roll isolation, given less time, but are more often provided with an assistant.

At least among pediatric dentists, contrary to expectations and past studies, there was no effect upon the quantity of sealants placed due to insurance, years in practice, and geographical regions. All of these variables have been shown to impact significantly on sealant utilization among general dentists.[4,10,12,13]

The NIDR finding that twice as many sealants were placed in some areas of the country was not reflected in results of this survey. A possible explanation might be that general dentists are more greatly influenced in sealant utilization than pediatric dentists by regional variables. There was a significantly higher rate of optimal fluoride in the low sealant areas and nonsignificant tendencies to have larger practices and place less sealants. This may be a possible reason that, although the quantity of sealants placed in the low sealant areas was not significantly less, the access and efficiency of the sealants placed were significantly less. The low sealant, high fluoride areas would tend to treat more

low caries patients and tended to place fewer sealants. This tendency might be exacerbated among general dentists causing the dramatic differences in sealant prevalence observed by the NIDR.

The perceived indication for sealants by the pediatric dentists was quite high, at 85 percent of all newly erupted molars. This perception was positively correlated with the quantity, access, efficiency, and delegation of sealant placement and negatively correlated with its cost. But again, it was not correlated with and, therefore, does not explain the NIDR prevalency finding. Again the variation may be reflective of a greater diversity of opinions concerning sealants among general dentists.

Conclusions

- ☐ Delegation of sealant placement significantly increases its quantity and efficiency. Smaller practices, however, can maintain access to sealant care without delegation.
- ☐ State Practice Acts concerning sealant delegation significantly affect delegation patterns. Pediatric dentists in states that allow delegation only to hygienists delegate much less. When given the choice, pediatric dentists delegate to assistants.
- ☐ Regional differences in sealant prevalences found by the NIDR in 1987 are not reflected in the sealant practices of pediatric dentists.
- ☐ Cotton roll isolation for sealant placement was found to be less expensive, require less time, be safer, and have superior perceived retention rates as compared to rubber dam isolation.
- ☐ Sealant placement was thought to be safer than a fluoride treatment with reported injuries mostly due to isolation techniques.

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CLINIC

Caries-like lesion initiation and progression in sound enamel following argon laser irradiation: An *in vitro* study

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The initial experimentation with lasers (light amplification by stimulated emission of radiation) in dentistry began almost forty years ago, when a group of dental scientists proposed that the ruby laser could be utilized for vaporization and ablation of caries.[1-3] These pioneers in laser research found that caries could be successfully removed with a laser device; the potential for thermal damage to the underlying pulpal tissue, adjacent soft tissue and osseous structures, however, was significant. During the past decade, laser technology has made remarkable advances, with clinical application of laser technology in the treatment of soft tissue diseases in both medicine and dentistry becoming commonplace. These advances were made possible by the improvement in laser design, which has allowed for precise control of the energy emitted, focusing the beam to a specific depth and collimating the beam to a selected diameter.[4-6] Most importantly, the ability to control the field effect of the laser has allowed for minimal transmission of thermal energy to adjacent tissues. Currently available lasers adapted for utilization in dentistry include carbon dioxide, Nd:YAG and argon lasers. Each of these lasers provides a different wavelength of light (Nd:YAG = 1.06um; CO_2 = 10.6um; Argon = 488– 514nm), a varied degree of energy absorption by tissue and depth of penetration.[6-8]

Recently, there has been a resurgence of interest in the role of lasers in prevention and treatment of enamel and dentinal caries. At relatively high energy levels, it is possible to produce a surface melt and effectively seal an enamel or dentinal surface, while producing only a 4° C increase in pulpal temperature.[9,10] This process results in a surface that has lost a significant amount of its organic, carbonate, and water con-

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tent.[8,11-15] With loss of carbonate and a reduction in lattice strain of lased enamel and dentin, acid solubility is reduced. Recent investigations have shown that significant reductions in the extent of artificial caries formation and enamel solubility occur after laser irradiation of enamel and dentin, even with relatively low energy levels (10 to 50 Joules/cm^2).[7,8,11-17] *In vitro* research involving laser applications in a number of facets in dentistry has been explored. These studies have shown that the laser may be a useful instrument in the practice of dentistry. These findings include: creating an enamel or dentinal surface suitable for resin bonding; fusing hydroxyapatite to enamel in fissures and acting as a "biological" seal; and sealing the root apex with lased dentinal and enamel chips during endodontic procedures.[7,14,18] Most recently, the argon laser has been approved for initiating the setting reaction with visible light-cured resins.[4-6] Argon-curing of resin materials has been shown to enhance the physical properties and degree of polymerization of the resin, while reducing the polymerization time by 75 percent.

A previous study examining the effect of argon laser curing of sealant material on microleakage resulted in unexpected and interesting findings.[19] With argon laser-cured sealants, the incidence of wall lesions were similar at lesion initiation, but significantly different, following lesion progression when compared with paired controls. An unexpected finding was that the lased surface enamel adjacent to the sealant material showed significant reductions in lesion depths both at lesion initiation and progression periods, when compared with paired, control surface enamel. This apparent caries-resistant phenomenon led us to the present study. The purpose of this *in vitro* study was to determine the effect of argon laser irradiation on caries-like lesion initiation and progression in human enamel.

MATERIALS AND METHODS

A total of twenty caries-free human molar teeth were selected for this *in vitro* study. The buccal and lingual surfaces were examined with a binocular, dissecting microscope at a magnification of 16x to ensure that these surfaces were free of clinically detectable white spot lesions. Following a fluoride-free prophylaxis, an acid-resistant varnish was placed leaving two windows of sound enamel exposed on both the buccal and lingual surfaces. With each specimen, one buccal window and one lingual window were exposed to argon laser irradiation at 250 milliwatts for 10 seconds (12 Joules/cm^2). The remaining buccal and lingual windows were protected from laser irradiation and served as paired controls. Caries-like lesions were created using an acidified gel (pH 4.2) without exogenous calcium, fluoride or phosphate added. Following a six-week exposure period, longitudinal sections were prepared for polarized light evaluation. The remaining portions of the specimens were returned to the acidified gel for lesion progression. Longitudinal sections were prepared following two separate, lesion progression periods. The sections from the lesion initiation and both lesion progression periods were imbibed with water and photomicrographs were taken. Mean surface zone and body of the lesion depths were obtained using a digitized tablet and taking five measurements along the inner aspect of the surface zone and body of the lesion. At each study period, forty paired lased lesions and forty control lesions were available for statistical analyses. Because of the research design, the surface zone and body of the lesion depths from the lased and control groups were compared using a paired t-test, thereby limiting tooth to tooth variability in the statistical analysis.

RESULTS

Following lesion initiation, surface zone depths were similar for both the control and lased lesions (Table 1). The mean depth for the body of the lesion for the control group was 117um and 69um for the lased group. The body of the lesion depth had been reduced by 41 percent for those lesions exposed to argon laser irradiation when compared with the paired control lesions ($p<0.05$). Representative paired control and lased windows (Figure 1) from the same specimen showed certain differences following lesion initiation. The effect of argon laser irradiation resulted in a marked reduction in the body of the lesion depth for the laser-treated enamel window (78um) when compared with the control window (120um). With argon laser irradiation, the body of the lesion was composed primarily of pseudo-isotropic enamel, indicating a pore volume of exactly 5 percent. In contrast, the control lesion had a positively birefringent body of the lesion indicating a pore volume of greater than 5 percent.

Following the first lesion progression period (Table 1), surface zone depths were similar for both control and lased groups. Mean body of the lesion depths, however, were significantly different ($p<0.05$). With control lesions, the mean body of the lesion depth was 158um. In contrast the laser treatment group had a mean depth of only 103um. Argon laser irradiation before caries initiation resulted in a 35 percent reduction

in lesion depth for the argon laser group, even after lesion progression. The body of the lesion depth had increased by 41um for the control group and 34um for the laser-treated group ($p<0.05$) between lesion initiation and the first lesion progression (Table 2). Representative paired control and lased windows (Figure 2) from the same specimen following lesion progression period I both showed intact, negatively birefringent (<5 percent pore volume) surface zones. The mean body of the lesion depth for the argon laser-treated window (132um) was considerably less than that for the control window (165um). Following the first lesion progression period, the representative lesion in the laser treatment group possessed a body of the lesion composed primarily of pseudo-isotropic enamel (5 percent pore volume) with a central region of positive birefringence (>5 percent pore volume). In comparison, the paired control lesion, located adjacent to the lased lesion on the same buccal surface, had a predominantly positive birefringent body of the lesion.

Following the second lesion progression period, the mean surface zone depth for the laser-treated group was slightly greater than that for the control group (Table 1). The mean body of the lesion depth for the control group was 221um compared with 135um for the argon laser group ($p<0.05$). The lesion depth had in-

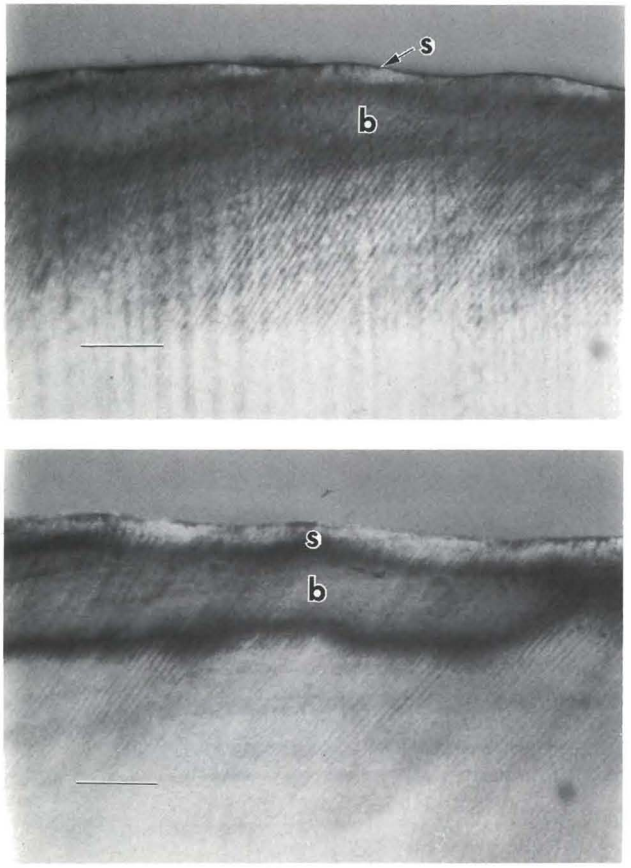

Figure 1. Lesion initiation period. *A) Representative Lesion from Argon Laser Irradiation Group. The body of the lesion has a mean depth of 78um and is composed of primarily pseudo-isotropic enamel (pore volume = 5 percent). B) Representative Paired Lesion from Control Group. The body of the lesion is predominantly positively birefringent (pore volume >5 percent) and has a mean depth of 120um. S = Surface Zone; B = Body of Lesion. (Water Imbibition, Polarized Light. Space Bar = 100um)*

Table 1 ☐ Argon laser irradiation effect on caries initiation and progression.

	Control lesions (mean depth ± sd)	Lased lesions (mean depth ± sd)
Lesion initiation period		
Surface zone (n=40)	33 ± 7um	31 ± 8um
Body of lesion* (n=40)	117 ± 24um	69 ± 18um
Lesion progression period I		
Surface zone (n=40)	34 ± 8um	33 ± 10um
Body of lesion# (n=40)	158 ± 29um	103 ± 22um
Lesion progression period II		
Surface zone (n=40)	29 ± 9um	36 ± 11um
Body of lesion@ (n=40)	221 ± 32um	135 ± 21um

*Lesion Initiation Period: $p<0.05$ for body of lesion depth between lased and control groups
#Lesion Progression Period I: $p<0.05$ for body of lesion depth between lased and control groups
@Lesion Progression Period II: $p<0.05$ for body of lesion depth between lased and control groups

Table 2 ☐ Argon laser irradiation effect on incremental increase in body of the lesion depth following lesion progression.

	Control lesions (mean increase ± sd)	Lased lesions (mean increase ± sd)
Lesion progression I* (LPI depth - LI depth) [n=40]	41 ± 7um	34 ± 6um
Lesion progression II# (LPII depth - LPI depth) [n=40]	63 ± 11um	32 ± 8um
Overall depth increase@ (LPII depth - LI depth) [n=40]	104 ± 17um	66 ± 14um

*Lesion Progression Period I (lesion progression I depth - lesion initiation depth): $p<0.05$ for body of lesion depth increase between lased and control groups
#Lesion Progression Period II (lesion progression II depth - lesion progression I depth): $p<0.05$ for body of lesion depth increase between lased and control groups
@Overall Depth Increase (lesion progression II depth - lesion initiation depth): $p<0.05$ for body of lesion depth increase between lased and control groups

creased 63um for control lesions and 32um for the laser-treated group between the first and second lesion progression ($p<0.05$). A single argon laser treatment of sound enamel prior to caries initiation resulted in an overall reduction of 39 percent reduction in mean body of the lesion depth. Representative paired lesions (Figure 3) from control and lased windows following the second lesion progression period had mean body of the lesion depths of 232um and 163um, respectively. Both lesions had intact surface zones; the surface zone from the control lesion showed focal, superficial areas of positive birefringence, however, indicating a secondary surface attack.

DISCUSSION

A single exposure to argon laser irradiation of sound enamel resulted in significant reductions in lesion depth following lesion initiation and lesion progression, with an overall reduction of 39 percent in lesion depth for argon laser-treated enamel. The dramatic reduction in lesion depth may be due to the surface effect of laser irradiation on enamel. With laser irradiation, the composition of enamel may be altered with reduction in organic, carbonate, and water content.[8,11,12,14] The reduction in carbonate content results in increased resistance to acid dissolution. In fact, it has been shown previously in laboratory studies that irradiation with argon, Nd-YAG and carbon dioxide laser at energy levels ranging from 10 to 70 Joules/cm^2 resulted in marked resistance to demineralization in artificial caries systems and decreased enamel solubility.[8,11-15] It has been estimated that the effect of laser irradiation may result in lowering of the threshold pH at which enamel dis-

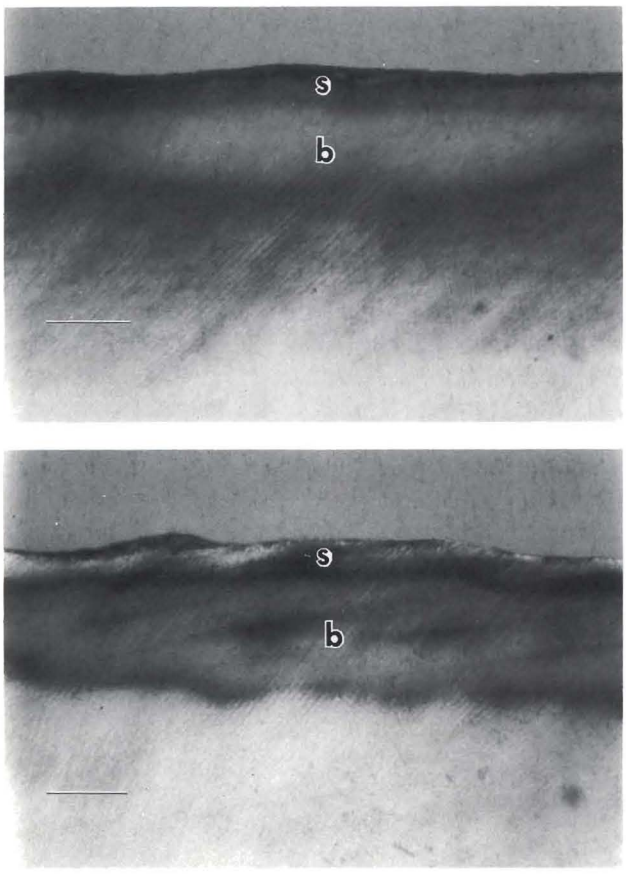

Figure 2. Lesion progression period I. *A) Representative Lesion from Argon Laser Irradiation Group with a mean body of the lesion depth of 132um. B) Representative Paired Lesion from Control Group with a mean body of the lesion depth of 163um. S = Surface Zone; B = Body of Lesion. (Water Imbibition, Polarized Light. Space Bar = 100um)*

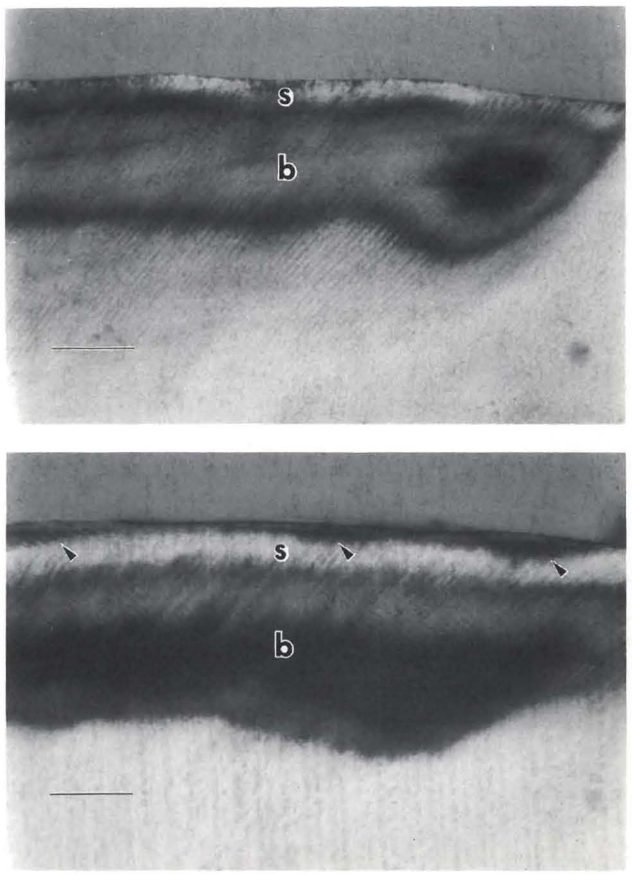

Figure 3. Lesion progression period II. *A) Representative Lesion from Argon Laser Irradiation Group with a mean body of the lesion depth of 135um. B) Representative Paired Lesion from Control Group with a mean body of the lesion depth of 232um. Note the positively birefringent areas within the surface zone (arrows) indicative of secondary surface attack. S = Surface Zone; B = Body of Lesion. (Water Imbibition, Polarized Light. Space Bar = 100um)*

solution occurs from pH 5.5 to 4.78.[16] In other words, a five-fold increase in the concentration of an organic acid, such as acetic acid, would be necessary to solubilize a similar amount of lased enamel compared with untreated enamel.

Laser irradiation has also been noted to result in creation of microspaces within enamel.[8,11-14] These microspaces may be of importance in reducing enamel solubility. During the demineralization phase of caries formation, various mineral phases calcium, phosphate and fluoride ions become dissolved in the acid solution and are released into the oral environment. It has been speculated that the microspaces created by laser irradiation may trap the released ions and act as sites for mineral reprecipitation. This deposition of released mineral phases may be further enhanced by the fact that lased enamel has an increased affinity for fluoride, phosphate and calcium ions. The release of fluoride may be the critical factor in reprecipitation of mineral phases within lased enamel and an overall reduction in enamel solubility. It has recently been reported that a fluoride concentration of as little as 0.01ppm will result in a six-fold decrease in enamel solubility for lased enamel.[16] The threshold pH for enamel dissolution is lowered from 5.1 to 4.3. In the present study, acidified gelatin was maintained at a pH of 4.2, which allowed for demineralization to occur.[16]

Although the exact mechanism of caries resistance with argon laser irradiation is not known, the most likely mechanism would be alteration in the pore structure of lased enamel with entrapment and reprecipitation of mineral phases released during demineralization.[8,14] As previously stated, lased enamel has an increased affinity for fluoride, calcium and phosphate ions and it seems likely that mineral ions released during demineralization would become incorporated into adjacent lased enamel.[13,14] It is also possible that mineral phases and fluoride endogenous to the acidified gelatin could become incorporated into lased enamel; in a similar manner that mineral and fluoride ions within dental plaque may be incorporated into adjacent enamel. Due to the prolonged argon-laser irradiation (10 seconds), reduction in the organic content of surface enamel and perhaps alterations in mineral phases may have occurred.

Although the artificial caries system used in this study creates lesions in enamel that are identical histologically to enamel caries formation *in vivo*, one must consider that this system subjects the enamel to a continuous aggressive, cariogenic challenge without periods of remineralization. In contrast, caries formation *in vivo* is characterized by periods of demineralization interspersed with periods of remineralization with oral fluids. Despite the continuous cariogenic challenge, the lased enamel demonstrated a remarkable resistance to lesion initiation and progression. This caries resistance occurred with only a single exposure to argon laser irradiation before caries initiation. One can only speculate that laser irradiation following lesion initiation and lesion progression may have resulted in an even greater degree of caries resistance, as determined by lesion depth. Certain clinical implications may be drawn from this study. It would appear that laser irradiation of sound enamel may be of considerable benefit in prevention of enamel caries. Because it is possible to collimate the beam to a specific diameter and focus the beam to a selected depth, it may be possible to irradiate interproximal areas, especially beneath the contact area, which may be particularly susceptible to caries development.[4-6] The potential also exists for improving caries resistance in enamel forming pits and fissures. This may occur while one is actually utilizing an argon laser

A single exposure to argon laser irradiation made the tooth enamel more resistant to dental caries.

for polymerizing a visible light-cured sealant material. In addition, fluoride uptake may be facilitated by laser treatment of sound and hypomineralized enamel before fluoride treatment.[11,13,14] Current research efforts are directed toward determining the effect of laser irradiation on the white spot lesion of enamel. The potential for either arresting the progress or reversing the caries process with laser irradiation of enamel caries would appear to exist.

CONCLUSIONS

The conclusions drawn from this *in vitro* study are:

- ☐ Argon laser irradiation resulted in significant reductions in body of the lesion depths following lesion initiation and both lesion progression periods.
- ☐ Exposure of sound enamel surfaces to argon laser irradiation enhances the ability of lased enamel to resist a constant *in vitro* cariogenic challenge.
- ☐ Although the exact mechanism of caries resistance following argon laser irradiation is not known, the most likely mechanism would be alteration in the pore structure of lased enamel with entrapment and reprecipitation of mineral phases released during demineralization.

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EFFECTS OF LASER IRRADIATION AND CHEMICAL INHIBITORS ON DISSOLUTION OF DENTAL ENAMEL

In the presence of only 0.01 ppm of fluoride, the expected effect of lasing is even more dramatic: the threshold pH is reduced from 5.14 to 4.31; the quantity of acid needed to reach the threshold pH is increased over six times from 3.26 to 20.8 m*M*, and the lased material does not dissolve at all at pH 4.5. Even at pH 4.0, the solubility for the lased material is a factor of 6 lower than that for the unlased in the presence of 0.01 ppm fluoride.

These calculations show that lasing and fluoride are expected to be synergistic and that very modest amounts of fluoride would be expected to protect lased enamel from even a vigorous acid challenge. In fact, no dissolution is expected at pH 4.5 from enamel crystallites that have been converted to site No. 2 dissolution control and behave as though their solubility product were 10^{-130} as long as there is as little as 0.01 *M* fluoride present.

Fox, J. L. *et al:* Combined effects of laser irradiation and chemical inhibitors on the dissolution of dental enamel. Caries Res, 26:333–339, September-October 1992.

Eruption problems: A cautionary tale

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Eruption cysts are a specific type of soft tissue cyst associated with erupting primary or permanent teeth. Some authors classify them as a form of dentigerous cyst, but they are recognized as a distinct clinical entity. They are uncommon, accounting for fewer than 1 percent of all cysts.[1] Controversy on the matter of their occurrence is expressed in the literature: Seward reported a series of British and overseas studies and noted that eruption cysts were commoner in females (66 percent) and in the mandible; Anderson reporting from the United States, noted, however, that eruption cysts were more common in males (65 percent) and in the maxilla (61 percent).[2,3]

Both cases reported here were in male children, one in the maxilla and one in the mandible. In the latter case there was also a significant medical history.

CASE 1

A two-year-old male was referred to the Dental Hospital by his general dental practitioner because of an enlarged ulcerated area in the region of his erupting maxillary right second primary molar. The child was prescribed antibiotics and observed by the dentist over a five-day period. The mother reported previous swelling of the right side of the face and intraoral bleeding from the E/ area, but this had ceased since the course of Amoxil antibiotic. On examination the child was fit and well, but there was a mass of fleshy tissue overlying the E/ area, which appeared to have been traumatized by the opposing tooth. Radiographic examination was unremarkable. A provisional diagnosis of a traumatized eruption cyst was made. The mother was reassured, and the child was prescribed a chlorhexidine mouthwash for topical application to the site and given a new appointment for a week later. At that appointment the mother reported that the child was better, but the appearance of the E/ area was the same as on the previous visit (Figure 1).

Figure 1. A lesion in the area of the maxillary right primary second molar.

I am grateful to colleagues in the Department of Oral Surgery for their care of the first case at the time of operation and to Miss C.A. Reid, Consultant Plastic Surgeon for her continuing interest and advice with the second case. I am indebted to Miss D. Kingsbury for her painstaking work on this manuscript.

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The child was reviewed again two weeks later, when it was noted that the lesion had bled occasionly during the intervening fortnight. At that stage the child was referred for excision of the lesion under a general anesthetic. On recovery from the anesthetic, there was profuse bleeding from the margins of the wound, to the extent that the child had to be re-anesthetized and the area sutured. Subsequent persistent bleeding necessitated the child's admission to hospital overnight. Thereafter healing was uneventful and the child was examined regularly over three months, during which time the E/ erupted with a margin of tissue around it that was of a similar blue hue to a classic eruption cyst (Figure 2).

The histopathology report on the excised tissue suggested that the lesion had been a reactive one consistent with a pyogenic granuloma. The patient was subsequently discharged back to his dental practitioner.

Case 2

The second case was a fourteen-month-old male, one of a twin who was born with a lymphangioma involving the left side of his face, neck and chest (Figure 3). His medical history was further complicated by hydrocephalus, which was treated with a shunt at eight months, when he had experienced his first convulsion. His medication was initially 100 mg carbamazepine bd, but this was changed subsequently to 1g vigabitrin daily. He was seen initially at a combined plastic surgery clinic because of probable teething difficulties in his upper left quadrant. His mother complained that the swelling in his cheek became brawny red and he experienced screaming fits for twenty-four hours or longer, all of which she associated with his efforts at teething in that quadrant.

On examination the maxillary left quadrant had only the primary canine erupted, but the /D was thought to be palpable. The soft tissues in this area were hypertrophic, but otherwise unremarkable. Radiographs of the area did not reveal any abnormality. The parent was reassured and the child prescribed a sugar-free paracetamol preparation.

Three months later the child was referred to the Dental Hospital because of a blush swelling in association with the /D for approximately one week. There were no symptoms. On examination there was a blush-white pedunculated swelling over the crown of /D (Figure 4). Only the D/ was erupted. A provisional diagnosis of pyogenic granuloma was made and in view of the experience with the first case, and because there was no evidence of trauma, the tissue was left *in situ*. At review, four months later the /D, was partially erupted and most of the granulomatous tissue had receded (Figure 5).

Five months later the child was seen again because of recurrent reddening of the lymphangiomatous area in his left cheek, an increased frequency of convulsions and bleeding gums. The child was also now taking Aug-

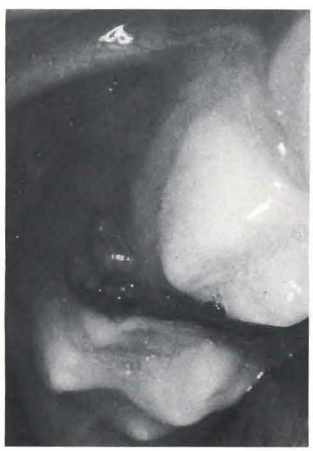

Figure 2. Eruption of the maxillary primary second molar occurred after treatment. The margin of tissue around the tooth has the appearance of a classic eruption cyst.

Figure 3. Fourteen-month-old boy, born with lymphangioma of the left side of his face, neck, and chest.

Figure 4. A bluish-white pedunculated swelling was present over the left mandibular first primary molar.

Figure 5. Four months after the condition shown in Figure 4, the tooth was partially erupted and the granulomatous tissue had receded.

mentin antibiotic, (250 mgs at night), to reduce the inflammation in the cheek tissue. The mother was sure the symptoms related to her child's efforts at teething and in consultation with the plastic surgeon it was reluctantly decided to remove the tissue overlying /DE under a general anesthetic.

The tissue was excised and a pack of Whiteheads varnish on ribbon gauze placed over the wound with resorbable sutures. Two weeks later at review the /DE were erupting well. The child was still having convulsions as frequently and the left cheek was red on occasions. He was referred to his general medical practitioner for investigation of possible sinusitis.

The histopathology report on the excised tissue indicated that it had resembled a pyogenic granuloma without any evidence of lymphangiomatous malformation.

DISCUSSION

In both these cases, the children were referred initially because of eruption cysts. In the first case considerable trauma to the tissue indicated excision of the "cyst". Unfortunately, the lesion was in fact a pyogenic granuloma which bled profusely, necessitating the child's admission to hospital.

The second child was also referred to the Dental Hospital because of an eruption cyst. In this instance the tissue was not being traumatized, however, and as far as we could ascertain the child was asymptomatic. In addition, not only had we learned from the previous case to be more conservative in our approach, but we were also concerned that a mixture of hemangiomatous/lymphangiomatous tissue may have extended into the mandibular alveolar area and might present more severe problems of bleeding in this child.

Eventually with patience the tissue regressed together with eruption of the /D, but after considerable pressure from the parent we were persuaded to excise tissue in the /DE area to allow these teeth to erupt. At operation only a minimal covering of tissue was present over these teeth, which subsequently erupted normally. It was thought unlikely, therefore, that the eruption of these teeth was the cause of the child's persistent, worrying symptoms.

Numerous textbooks on pediatric dentistry urge caution when contemplating active intervention in eruption cysts. This would appear to be sound advice when consideration is given to the two cases reported here.

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Dental erosions caused by gastroesophageal reflux disease in children

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Maija Baer, MD
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It is believed that recurrent vomiting or regurgitation of gastric contents can lead to erosion of the teeth.[1] Erosion has been defined as a superficial loss of dental hard tissues by a chemical process that does not involve bacteria.[2] Eccles and Jenkins (1974) agreed on four different criteria, each of which can act as a diagnostic criterion of erosion in permanent teeth.[3] They also presented the grading of erosions according to the severity of the lesions. The cause of erosions may be extrinsic, due to influences outside the mouth, or intrinsic from sources within the mouth and body.

Dietary factors are probably the best known etiologic causes of erosions. For example citrus fruits and acid beverages dissolve enamel readily. A new grading for erosions due to dietary or intrinsic causes was created by Eccles in 1979.[4] This classification was an extension of the one proposed earlier, and was created to act as a guide to diagnosis.[3]

In addition to dietary factors, it is known that chronic vomiting and regurgitation can cause dental erosions.[1,5,6] Erosions of dental hard tissues, including occlusal surface erosions have been described in patients with anorexia nervosa and bulimia.[7,8] The literature is lacking information on dental erosions, however, in children diagnosed for gastroesophageal reflux (GER). In adults with upper gastrointestinal disorders, erosive lesions have been described to be rare.[9] In children with chronic respiratory symptoms, however, GER is common.[10-12] Although GER as such may not necessarily be of clinical significance, esophagitis may occur in children with GER and can be regarded as an indicator of clinically important GER.[12,13] Loss of dental hard tissue might also be such an indicator.

We have now studied the teeth of seventeen children with confirmed gastroesophageal reflux disease. In addition, two children in whom dental lesions led to GER diagnosis are described.

PATIENTS AND METHODS

The study group consisted of seventeen children, ages twenty-two months to sixteen years (median age 8.1 years), who attended a university hospital pediatric outpatient clinic for gastroesophageal reflux disease. There were twelve boys and five girls in the study group. The median age at the time of GER diagnosis was 5.0 years. The symptoms that led to GER diagnosis could be divided into three clinical groups, namely chronic respiratory symptoms (n = 10), gastrointestinal symptoms (n = 5), and dental disturbances (n = 2). Chronic respiratory symptoms group included children with asthma, recurrent obstructive bronchitis or re-

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current pneumonia. Gastrointestinal symptoms included recurrent abdominal pain, occasional regurgitation, or vomiting and dysphagia. All the children had received drug therapy after the diagnosis.

The GER diagnoses were firmly established with long-term esophageal pH recordings (18 to 24 hours) as previously published, and were in agreement with recently published diagnostic criteria.[12,14] The median percent time of pH below 4 during the total registration time was 11 percent (range 4.8-38.8 percent). The children with pathological GER were grouped according to whether the reflux episodes occurred mainly during the sleeping period, awake period, or during both of them.

The dental examination was performed within one year of the GER diagnosis in nine of the children; in the others, later. Two of the children had their teeth examined before the GER diagnosis. A total of five children had primary dentitions. Mixed dentitions were found in eight children and permanent dentitions in four patients. None of these children has used acid beverages or fruit juices daily.

RESULTS

In the present study dental erosions were classified according to their clinical appearance. This new classification based on children diagnosed to suffer from gastroesophageal reflux disease is shown in Table 1. The present grading for dental erosions was suitable for children with primary, mixed, and permanent dentitions. Figures 1 and 2 give examples of dental erosions of the grades 2 and 3 in children with GER.

Primary incisors showed white spots or etched appearance. The incisal edges of anterior teeth were thinned or grooved. Chalky and opaque lesions were seen all over the primary teeth. The most typical changes were small holes on occlusal surfaces of primary molars. In mild forms dentin was not involved. In more severe cases, the cupping became wider and a part or the whole occlusal surface could be ruined. In primary dentitions the occlusal surface seemed to show the most prominent changes with punched-out-appearance.

In permanent incisors etched appearance was typical. In mild forms, rounding and flattening of cusps of permanent molars and premolars were also detectable. In one case exposure of dentin on buccal and palatal surfaces was also seen.

Erosive lesions were found in thirteen of the fifteen children (87 percent) diagnosed to have pathological GER. In addition, dental erosions led to GER diagnosis in two children (Case reports 1 and 2). In children with complete primary dentitions, dental erosions were found in four of five of them, in seven of the eight children with mixed dentitions, and in all of the children with permanent dentitions.

In Table 2 the grades of erosion are correlated with the clinical classifications of GER. Severe lesions (grades 2 and 3) dominated among the children and were found in all clinical groups. Sleeptime reflux clearly resulted in loss of dental hard tissues of grade 3 (Table 3). It is noteworthy that daytime reflux can also cause severe structural defects.

Table 1 □ Clasification of primary and permanent teeth erosions caused by gastroesophageal reflux disease.

Grade of erosion	Type of erosion
Grade 0	No erosion
Grade 1	Mild opacities or white spots/etched appearance
Grade 2 (Figure 1)	Occlusal surface filled with small holes (punched-out-appearance), incisal edges thinned, flattening of cusps
Grade 3 (Figure 2)	Dentin exposure at the bottom of the holes on occlusal surfaces or dentin affected on other surfaces

Figure 1. Grade 2 dental erosions in a six-year-old girl with gastroesophageal reflux disease. Typical small holes on occlusal surfaces are seen.

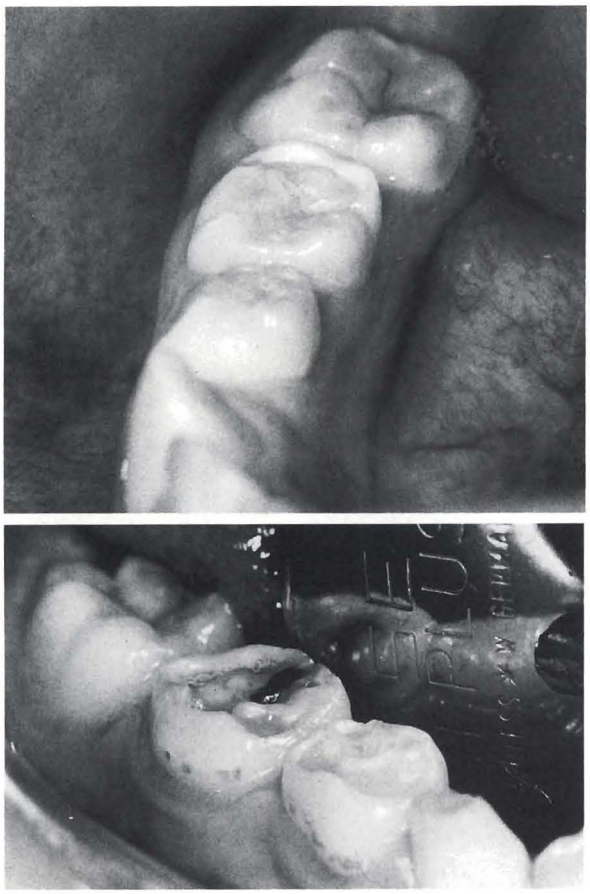

Figure 2. Grade 3 dental erosions in an eight-year-old girl (top) and in an eight-year-old boy (bottom) with gastroesophageal reflux disease. Top, dentin exposure on occlusal surfaces can be seen. In addition, rounding and flattening of cusps of the permanent molar is obvious (grade 2 lesions). Bottom, almost the whole occlusal surface is ruined. Also raised amalgam restoration can be seen.

Table 2 ☐ Association of clinical grouping of symptoms in children with confirmed gastroesophageal reflux disease and grade of dental erosions.

	Grade of dental erosion			
Clinical groups	Grade 0 N	Grade 1 N	Grade 2 N	Grade 3 N
Chronic respiratory symptoms (N = 10)	0	2	5	3
Gastrointestinal symptoms (N = 5)	2	0	1	2
Dental changes (N = 2)	0	0	0	2

Table 3 ☐ Grade of dental erosions associated with gastroesophageal reflux occurring during sleep or awake periods.

	Grade of dental erosions			
Period	Grade 0 N	Grade 1 N	Grade 2 N	Grade 3 N
Reflux episodes mainly during the sleep period (N = 10)	1	2	2	5
Reflux episodes during sleep and awake periods (N = 5)	1	0	3	1
Reflux episodes mainly during the awake period (N = 2)	0	0	1	1

CASE REPORTS

Case 1

Routine dental examination revealed massive erosive lesions in the primary molars of an eight-year-old boy. An orthopantomograph revealed that his dental maturity was almost two years delayed. The first eruption

Acidic activity is great enough to cause flattening of cusps and even exposure of dentin.

period had just started. Newly erupted permanent molars and maxillary incisors were observed. Grade 3 erosive lesions were detectable in maxillary and mandibular primary molars. A history of fruit-juice intake for a short period of time when he was five years old was established. He complained of no gastrointestinal symptoms, nor had he had recurrent respiratory tract infections. His teeth showed lesions typical of GER for which he was referred for pediatric gastroenterologic consultation. The long-term esophageal pH recording showed pathological GER with 14.9 percent of pH of the total registration time to be below 4.

Case 2

A sixteen-year-old boy was referred for pediatric dental consultation by a general practitioner because of massive dental erosions, which seemed to get worse despite local preventive procedures. He complained of mild regurgitation symptoms. His teeth were very sensitive. Massive erosions were seen on lingual and palatal surfaces of the anterior teeth. Cupping was detectable in molars and premolars. He had a normal salivary secretion rate and normal buffering capacity. This boy was referred for further pediatric gastroenterological consultation. Gastroscopy revealed chronic esophagitis both macroscopically and on histologic examination. Long-term esophageal pH recording showed a high number of short-lasting reflux episodes especially during daytime. The total time of a pH below 4 was only 4.8 percent, but still considered pathological. It is concluded that this boy had clinically significant GER, leading to massive dental erosions typical of reflux disease.

DISCUSSION

The present study provides a new classification of dental erosions in children diagnosed to have gastroesophageal reflux disease. The grading created by Eccles, where the erosions are caused by dietary or intrinsic factors is meant for studying permanent teeth and thus not suitable.[4] Nor could the classification of permanent-teeth enamel lesions seen in celiac disease and *dermatitis herpetiformis* be used.[15,16] The present new grading takes into account the severity of erosive lesions caused by GER, both in primary and permanent teeth.

We found almost all children with pathological GER to have dental erosions of the same type, but of different grades. It is emphasized that our patient material consists mostly of older children and not of the classical

Daytime reflux may also be clinically important.

GER in young infants with symptomatic vomiting or regurgitation. Clinically important GER is often found in children with recurrent lower respiratory tract symptoms.[12] It now seems that loss of dental hard tissue is an important sign of pathological GER in these children. We suggest that dentists become capable in screening and identifying clinically important, silent GER. In fact, the two children primarily studied because of severe dental erosions had clinically silent GER disease.

Reflux episodes during the sleeping period were connected to all grades of erosions, but most of them had grade 3 lesions. Two of the children did not show any dental erosions. One of them was a three-year-old boy with a short history of abdominal symptoms and instant GER diagnosis resulting in medical treatment. He was also found to have gastritis due to *Helicobacter pylori* infection. The other one was a fifteen-year-old boy with also a short history of gastric symptoms. Maybe permanent teeth are more resistant to reflux destruction than the primary ones. The two other children with mild opacities (grade 1) had had their GER diagnosis made several years earlier. One of them had already lost all his primary teeth, which may have been severely affected.

The present material consists mostly of children with supine reflux periods. We want to stress, however, that daytime reflux may also be clinically important as two of the children with only daytime reflux showed grade 2 or 3 dental erosions. Perhaps the great number of daytime reflux episodes could explain the massive dental changes seen in these children.

Primary anteriors did not show palatal loss of enamel, but etched appearance was common. Perhaps the tongue protected the palatal surfaces of the teeth. Small holes

on the occlusal surfaces of primary molars were typical, but raised amalgam restorations could be seen in these children. In many cases it is difficult to tell for how long the reflux disease has lasted. Nevertheless it seems obvious that dental changes are best seen in children who have suffered from GER for a long time or where the disease has been cured but relapsed several times. The experience of the authors is that lesions, especially in primary teeth, may quickly worsen, and a great deal of attention should be paid, therefore, to these children. Other factors of importance are the saliva, its flow rate and buffer capacity, as well as the degree of enamel mineralization of the child. In addition bad dietary habits combined with GER may ruin the primary dentition quickly. All children with GER disease should receive dietary advice.

In conclusion, children with confirmed GER disease should have their teeth routinely checked. It remains to be seen whether also more physiologic GER in otherwise healthy vomiting young infants causes loss of dental hard tissues. Young and school-age children with dental erosions of the types described here, even though in apparent good health, should be sent for pediatric gastroenterology consultation, including long-term esophageal pH recording.

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SALIVARY CLEARANCE IN CHILDREN

Although it is known that nursing bottle caries depends on the feeding pattern in infancy, the present results suggest that the upper anterior buccal site in a no-spacing arch will be the most cariogenic site in a child's mouth because it has the lowest rate of salivary clearance.

Watanabe, S.: Salivary clearance from different regions of the mouth in children. Caries Res, 26:423-427, November-December 1992.

DEMOGRAPHICS

The health of our children and their use of medical services

H. Barry Waldman, BA, DDS, MPH, PhD

America's children are more likely to be fat, to commit suicide, to be murdered or to get low scores on standardized tests in the years since the 1960s..."[1]

"More than 14 percent of children lived in one-adult households in 1988, compared to 5.5 percent in 1960, and the percentage of married women in the labor force with children under age 6 rose from 18.6 percent in 1960 to 57.1 percent in 1988."[1]

"There really are children in poor health" was the conclusion of an earlier review in the Journal of Dentistry for Children.[2] In 1987, 1.8 million children were reported to be in fair or poor health, with a greater incidence reported for:

- ☐ Children in lower income families.
- ☐ Minority children.
- ☐ Children in single parent family arrangements.
- ☐ Children living in the Southern region of the nation.
- ☐ Children living in the central sections of Metropolitan Statistical Areas.

A continuing flow of data from national health surveys provide further details on illnesses of children and their use of health services in terms of an extended series of demographic characteristics. If we believe that caring for the oral health of children necessitates an increased appreciation of the general medical and social conditions of youngsters, then pediatric practitioners must continue to expand their awareness of factors beyond the traditional limiting concerns of dentists.

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SOURCES OF INFORMATION

The 1988 National Health Interview Survey on Child Health and the 1989 National Health Interview Survey are part of a continuing nationwide survey by household interview. More than 47 thousand households containing more than 120 thousand persons were surveyed in each study. In the 1988 study, data were collected on more than 17 thousand children with an overall response rate of 90 percent.[3,4] The 1989 National Ambulatory Medical Care Survey was a year long probability sample survey of 2,535 office-based nonfederal physicians. (Note: excludes visits to emergency rooms or hospital outpatient departments.) There was a 74 percent physician response rate.[5]

In addition the Health Insurance Association of America annually issues an extended compilation of government agency and other third-party, health and insurance data that provide a general oversight of developments in this subject area.[6]

FINDINGS

Patterns of visits

- ☐ Between March 1989 and March 1990, visits to pediatricians accounted for an estimated 87 million visits (12.6 percent of almost 700 million am-

bulatory care visits made to physicians in the United States).

- ☐ White children accounted for almost 80 percent of all visits to pediatricians; 11 percent were by black children. Visit rates per one hundred children were 108 for white children, 77 for black children and 113 for "other" children (including Asian/Pacific Islanders and American Indian/Eskimo/Aleut). In all racial groups, there were more visits to pediatricians by males than by females (Table 1).
- ☐ A negative relationship exists between the age of the patient and the number of visits to pediatricians. About 60 million visits (approximately 70 percent of all visits to pediatricians) were made by children less than six years of age. Children between six and ten years of age accounted for 16.6 percent of visits. Children between eleven and fourteen years accounted for 7.5 percent of visits to pediatricians.[5]

The particular emphasis by pediatricians on the care of the very young child (with increasing levels of care by general practitioners and other specialists for children over five years of age) should be of special note for pediatric dentists who work closely with physicians in the care of youngsters.

- ☐ Younger children (under five years of age), had more physician encounters and hospital discharges than older children. While white children and children in higher income families had more physician contacts than black children, black children and children in lower income families had more discharges from hospitals than their white counterparts (Table 2). (See later discussion on acute and chronic illness)

Patterns of illnesses

- ☐ Thirty-eight percent of children were reported to have had a series of nine infectious diseases.*
- ☐ The most common of these conditions was repeated ear infections, affecting a quarter of all children. White (nonHispanic) children, children in higher income families, those with health insurance, routine health care and more physician contacts had a higher reported incidence of repeated ear infections than their respective counterparts (Table 3).
- ☐ Among teenagers {13-15 years of age) repeated tonsillitis was the most common disease. For the most part, the reported incidence of tonsillitis followed the same demographic pattern as that of repeated ear infection.

In all probability, the higher reported incidence of both these medical conditions in these groups of children is reflection of the greater access to routine health than that of white (Hispanic) and black children, children in lower income families, and those with no 1) health insurance, 2) no routine health care and 3) fewer physician contacts.[4]

- ☐ Girls were more than five times as likely to have had bladder urinary tract infections than boys.
- ☐ The educational levels of parents and guardian were associated with the general health status of children. Lower levels of parental or guardian education were associated with increased reports of

*Repeated ear infection, repeated tonsillitis or enlarged adenoids, pneumonia, frequent diarrhea or colitis, bladder or urinary tract infections, mononucleosis, hepatitis, meningitis and rheumatic fever.

Table 1 ☐ Number, percent distribution, and rate of office visits to pediatricians by race and sex for persons less than 22 years of age: 1989.[5]

Race and sex	Number of visits (in millions)	Percent distribution	Rate per 100 persons
White			
Male	36.3	42.3%	113
Female	31.9	37.1	102
Black			
Male	4.8	5.6	79
Female	4.5	5.3	75
Other*			
Male	1.9	2.3	125
Female	1.6	1.8	102
Totals	85.9	100%	109

* Includes: Asian/Pacific Islander and American Indian/Eskimo/Aleut
Note: Detail items do not equal total because the "unspecified" category of 4.8 million visits is included in the total.

Table 2 ☐ Children (less than 18 years of age) by physician contact, hospital discharge and selected sociodemographic characteristics: 1989.[6]

	Physician contacts (per child)	Hospital discharges (per 100 children)
Age		
Under 5 yrs.	6.7	7.7
5-17 yrs.	3.5	3.4
Gender		
Male	4.7	4.7
Female	4.1	4.6
Race		
White	4.7	4.7
Black	3.1	5.1
Income		
<$10,000	4.0	7.4
$35,000+	5.1	3.9

Table 3 ☐ Children (less than 18 years of age) by percent with repeated ear infection and repeated tonsillitis and selected sociodemographic characteristics: 1988.[4]

	Repeated ear infection	Repeated tonsillitis
Age		
1-4	29.4%	5.3%
5-11	28.0	13.9
12-17	19.6	19.1
Income		
<$10,000	21.5	11.2
$35,000+	28.5	13.8
Use of routine health care		
Yes	25.8	13.0
No	17.4	13.6
Health insurance		
Yes	26.6	14.0
No	20.1	10.0
Race and Hispanic origin		
White (non-Hispanic)	48.4	59.2
Black (non-Hispanic)	41.6	54.2
Hispanic	37.7	51.0
Annual number of physician contacts		
White (non-Hispanic)	4.5	3.1
Black (non-Hispanic)	2.8	1.7
Hispanic	3.5	2.4

Table 4 ☐ Children (less than 18 years of age) by parent education and selected sociodemographic characteristics: 1989.[3]

	Years of education of parent		
Number of children (in millions)	Less than 12 years 9.2	13 or more years 31.3	17 or more years 7.9
Fair or poor health	5.4%	1.4%	0.9
Limited activity due to chronic condition	6.7%	4.5%	3.4%
Number of days of restricted activity per person per year	9.8	10.1	9.5
Number of bed days due to illness	11.1	4.8	4.2
Number of physician contact per person per year	3.3	5.1	5.7
Number of short-stay hospital discharges per 100 children per year	6.8	3.8	2.4
Number of short-stay hospitals days per 100 children per year	45.2	22.1	20.2
Number of acute conditions per 100 children per year	215.3	308.3	319.0

Note: Children in a family were classified by the educational level of the adult with the highest education level.

Table 5 ☐ Health insurance coverage for children less than 16 years of age and seniors 65 years and older: 1986.[6]

Age	Private insurance	Government insurance	Totals
Less than 16 yrs.	71.9%	13.7%	85.6%
65 years and over	78.4	21.5	99.7

fair or poor health status of children and a number of specific, related health factors, including greater incidence of 1) limited activity due to chronic conditions, 2) number of bed days due to illness, 3) number of short-stay hospital discharges, and 4) number of short-stay hospital days. In addition children in families with lower levels of education had fewer physician contacts. Children in these same families, however, had fewer acute conditions as compared to children in families with higher levels of education (Table 4).

Note: For most sociodemographic groups, there tends to be an inverse relationship between the incidence of acute and chronic conditions. In all age categories of the national study, there was a tendency for lower levels of education to be associated with relatively lower estimates for the incidence of acute conditions and relatively high estimates for chronic conditions; the opposite pattern held for higher levels of education.[3]

Insurance coverage

Almost 15 percent of children less than sixteen years of age have no form of health insurance coverage, compared to less than one percent of seniors sixty-five years and over.[7]‡ Seventy-two percent of children are covered by private health insurance and almost 14 percent are covered by government programs. On the other hand, 78 percent of the population sixty-five years and older are covered by private insurance programs, and 21.5 percent by the government (Table 5). Surely it is unnecessary to emphasize the often reported association between the availability of health insurance and use of health services.[8]

"Contrary to intuition, those who are uninsured are not predominantly (in families of the) unemployed."[6] Two-thirds of the general uninsured population are in families of full-year steadily employed workers, most of whom are employed full-time. (Nearly a half of uninsured workers are selfemployed or employed in firms with fewer than twenty-five workers.)[6]

‡For a more extensive review of children without health insurance coverage, see a previous report in the Journal of Dentistry for Children.[8]

FROM THE PERSPECTIVE OF PEDIATRIC DENTISTS

We have become accustomed (and complacent?) over the usual reports that,

- ☐ There is a direct relationship between increasing family income and the use of the services of pediatric dentists.
- ☐ Fewer visits to pediatric dentists are reported for minority group children than for non-minority children.‡ Similar reports on the pattern of use of pediatrician services seem only to reinforce the findings in the dental literature. But the reality is that as a result of 1) the general constancy in the number of children (at about 64 million) and 2)evolving dental disease patterns, pediatric dentists will need to extend services to traditionally underserved populations of children, if they are to maintain their practice activity and financial return. Expansion of services will be dependent, however, upon increasing government support.

The availability of general medical information about youngsters in our communities, as well as their use of needed services, does offer pediatric dentists further insight into factors which affect the oral health of children. While it may sound somewhat mercenary, dental practitioners need to recognize the public relations opportunity that exists as result of the similarity between the relationship of various demographic characteristics and need for and use of dental and medical services. Indeed, pediatric dentists and physicians are (or should be) comrades in the battle to develop increased media (and in turn Congressional) attention to the plight of our children. The approximate three thousand plus pediatric dentists in the United States, may have limited lobbying impact.[10] But the combined efforts of pediatric dentists with almost forty thousand pediatricians would surely be more significant.[11]

Maybe that is the lesson to be learned. We would all agree that there is a need to improve the health care for the youngsters in our communities. The availability of more precise information is important. But the reality is that in times of economic difficulties and continuing Congressional attention to the needs of the older segments of population (whereas children do not vote, approximately two thirds of sixty-five-year-olds do vote) a continuing public relations effort is essential if we are to assure attention to the needs of our children.[11]

"...while government spending per child rose over the (last) three decades, spending on adults rose far more, and the status of children in the lowest one-quarter of the economic spectrum got worse."[1]

‡For an extensive review of who uses the services of pediatric dentists, see a previous report in the Journal of Dentistry for Children.[9]

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Emphasis by pediatricians on the care of the very young should be noted by dentists.

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REDUCING FAT INTAKE OF PRESCHOOL-AGE CHILDREN

In summary, a variety of fat reduction strategies can be applied to the diet of preschoolers to meet contemporary dietary recommendations. These fat-modified diets still can include favorite foods such as french fries and chocolate chip cookies that are relatively high in fat. Parents must be advised not to apply multiple fat-reduction strategies to preschoolers' diets since these diets will be very low in fat (<20% of calories) and potentially inadequate in energy and nutrients. It is important that caregivers know which foods to choose to ensure that the energy and nutrient requirements of fat-modified diets for preschoolers are met.

Sigman-Grant, M. *et al*: Dietary approaches for reducing fat intake of preschool-age children.
Pediatrics, 91:955-960, May 1993.

Increasing enrollment of very young children in educational programs

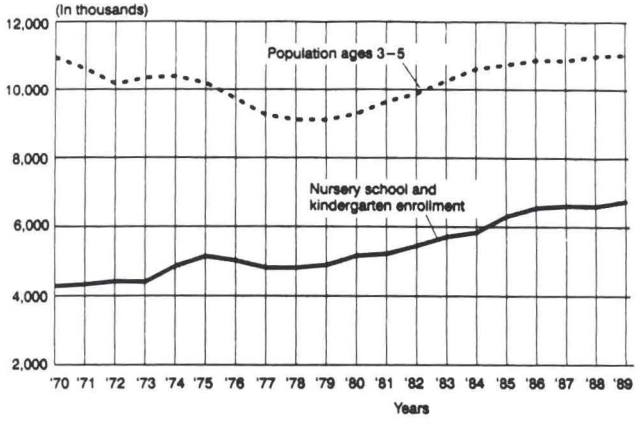
H. Barry Waldman, BA, DDS, MPH, PhD

In 1964, 9.5 percent of three- and four-year-old children were enrolled in an educational program.[1,2] By 1989 the percent of three- and four-year-old youngsters enrolled in nursery schools, kindergartens, and elementary school first grades had increased more than four fold to 39.1 percent. In 1989 almost three million children less than five years of age were enrolled in an educational program.[1,2]

Between 1970 and 1989, the population of children between three and five years of age decreased from approximately 11 million to 9 million youngsters and then increased back to approximately 11 million. Despite the changing numbers of children in this age cohort, the number of children enrolled in nursery schools and kindergarten increased almost continuously throughout this period from more than 4 million to almost 7 million youngsters (Figure 1). By 1989 more than half of the children between three and four years of age in some population groups were enrolled in an educational program.

As a result of a greater proportion of the population of very young children involved in early educational experiences, pediatric dental practitioners in the 1990s will be serving a population of children that may be quite different from the children served by their predecessors in the 1970s and 1980s. Children enrolled in these programs will be exposed to earlier and more educational situations and in turn they will be more accustomed to supervision and direction by nonfamily adults. Pediatric practitioners will be providing dental services to children who may have been introduced to the "world of dentistry" in a very different setting from the usual procedures in the office of a dental practitioner. Indeed, the initial approaches to providing dental services for these children may be quite different (easier?) than when treating very young children who had been reared without some early formal educational experiences.

But based upon various demographic characteristics, there are many differences between the number and percent of very young children who are being enrolled



Note: Adapted from Current Population Reports No. 452.[1]

Figure 1. Nursery school and kindergarten enrollment: 1970 to 1989.[2]

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in educational programs. The following presentation will review some of these differences.

SOURCE OF DATA

The Bureau of the Census conducts a monthly Current Population Survey of the civilian noninstitutionalized population in all fifty states and the District of Columbia. About 56,100 occupied households are eligible for interview every month. In the 1989 series of surveys, about 2,500 units were unavailable for interview. The annual October survey is used to produce data on the numbers and percent of the population enrolled in schools of education.[1,2]

DEMOGRAPHIC DIFFERENCES

By age

Three and four years old: In the past twenty years, there were dramatic increases in the percents of both white and black children enrolled in educational programs. While there was a greater percent of black youngsters enrolled in nursery schools, kindergartens, and elementary schools in 1969 and 1979, by 1989, the percent of white children enrolled in educational programs had caught up to the increasing rate of black child enrollment. Available data indicate that there was a far smaller percent of school enrollment for Hispanic and Mexican children (they may be of any race) than there was reported for the white and black child categories.

Five and six years old: By 1989, 95 percent of white and black children were enrolled in schools. A slightly lower percent of Hispanic and Mexican children were enrolled.

Seven to nine years old: Virtually all children were enrolled in school programs (Table 1).

By residence

In 1989, compared to metropolitan resident children, a smaller percent of young children (ages three and four years) living in non-metropolitan areas were enrolled in educational programs. The greatest percent of young children enrolled in these programs were residents of the out of central city sections of metropolitan areas (Table 2).

By family income

There was direct relationship between the increases in the percent of young children enrolled in educational programs and increasing family incomes. In each economic category, a smaller percent of black and Hispanic children, compared to their white counterparts, were enrolled, however, in programs.

In addition the percent of children enrolled in public nursery schools decreased with increasing family income. In each economic category, a smaller percent of white children, compared to their black counterparts, were enrolled in public nursery programs (Table 3).

Table 1 ☐ Percent of very young children enrolled in nursery schools, kindergartens, and elementary schools by race and ethnicity: 1969, 1979, 1989.[1,2]

	1969	1979	1989
Ages 3 & 4			
White	15.1%	33.9%	39.4%
Black	21.2	40.8	38.4
Hispanic		22.5	23.8
Mexican		20.5	22.7
Ages 5 & 6			
White	89.2	95.[illegible]	95.2
Black	84.1	96.0	94.9
Hispanic		92.5	92.8
Mexican		91.9	91.8
Ages 7 to 9			
White	99.4	99.2	99.2
Black	98.8	99.4	99.0
Hispanic		98.7	98.0
Mexican		99.0	98.2

Note: Hispanic and Mexican children may be of any race.

Table 2 ☐ Nursery school and kindergarten enrollment for children three and four years of age by race, ethnicity and place of residence: 1989.[2]

	Metropolitan areas		Nonmetropolitan areas
	Central city	Outside central city	
White	36.4%	43.8%	32.2%
Black	38.3	45.2	30.8
Hispanic*	20.7	25.7	

* May be of any race.

Table 3 ☐ Percent of children three and four years of age in nursery school by race, ethnicity and family income: 1989.[2]

	Family income			
	Less than $20,000	$20,000-$39,999	$40,000+	Totals
White	22.2%	32.6%	53.2%	35.4%
Black	24.3	37.2	44.0	31.3
Hispanic*	13.1	18.9	46.4	19.1
Of those children enrolled in nursery schools - percent in public nursery schools -				
White	53.6%	23.9%	16.1%	27.1%
Black	77.8	42.9		57.8

* May be of any race.

Table 4 ☐ Nursery school enrollment for children three and four years of age by race, ethnicity and mother's work activities: 1989.[2]

	Mother in labor force	Mother not in labor force
White	37.9%	32.8%
Black	35.6	24.2
Hispanic*	22.6	17.0

* May be of any race.

Reality is quite different from our expectations.

Mother in labor force

A greater percent of white, black, and Hispanic youngsters whose mothers were in the labor force, as compared to those whose mothers were not in the labor force, were enrolled in nursery schools (Table 4).

The most significant difference in nursery school enrollment rates were for full-day nursery schools for children whose mothers were in the labor force (44 percent) and for children whose mothers were not in the labor force (14 percent).[2] Nevertheless, it should be noted that, "There continues to be some question as to whether nursery schools act as child care."[2]

Despite these developments, the majority of three- and four-year-old children are not enrolled in nursery schools, regardless of whether their mothers are in the labor force or not.

SIGNIFICANCE FOR PEDIATRIC DENTISTS

Pediatric dentists will continue to provide the introductory dental experiences for the next generation of patients, but many of these youngsters will be more accustomed to supervision and direction by nonfamily adults. The need to adjust the presentation of dental care for even the youngest of children should be considered in terms of the Head Start, nursery school, and kindergarten opportunities that increasing numbers of children may have experienced.

It is all too easy to place children into various stereotyped categories and accordingly plan an "expectation approach" for introducing dental care for their needed health services. For example, it would seem reasonable to assume that all lower income or minority children have not had preschool educational opportunities or that mothers who are not in the labor force would prefer to care for their youngsters at home and not enroll them in preschool programs. The reality is quite different from our expectations.

The data presented in this report were for average population estimates and should be used as general indicators to aid practitioners as they begin a detailed history on each patient. Be prepared for increasing numbers of your patients to have had a "head start" in their education. It might make life a lot easier for them and even for you.

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DIETARY EROSION

Increased acidity in frozen fruit juices and dental implications

L.Z.G. Touyz, BDS, MSc, M Dent
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As the twentieth century draws to a close the world's annual fresh fruit crop production is measured in millions of tons. Because the appeal and consumption of fruits, as the fresh product or as processed juice, is universal, production and consumption will probably increase into the twenty-first century.[1] Significant proportions of all fruit harvests are processed into juice and other products. Typical of this is the 10 percent of the annual South African citrus production of 650,000 tons that is processed.[2]

Most fruit juices, including citrus and apple juice, have a low pH with the ability to decalcify teeth.[3,4] Dental erosion and attrition are attributed to decalcification from low postingestion, intraoral pH. The acidity is derived from low dietary juice pH, (from as low as pH 1.8 to pH 2.4), the strong buffering capacity of fruit juices (which results in a prolonged pH fall), and bacteriological acidogenic production from sugars in the juice.[3,5-8] The critical pH at which chemical dissolution of enamel occurs is accepted to be pH 5.5 ± 0.3.[3,6,7,9]

Fruit juices are consumed in large amounts in North America, and the effects of fruit juice consumption is well documented; excessive fruit juice consumption is directly cause related to dental attrition, erosion, abrasion, dental caries and mucosal burns.[8,10-14] Fruit juice is marketed aggressively as a soft drink, presented and consumed regularly in attractively designed cardboard or paper cartons, and is promoted as a health drink that is a good source of Vitamin C.[3] These aspects of fruit juice have been reviewed.[13,15] A modern undocumented trend among consumers, especially children, has been to freeze and suck and eat the fruit juice products. Frozen fruit juice is produced both commercially and domestically for consumption. Sucking the melting juice from the frozen product seems to heighten the organoleptic pleasurable experience; but the question arises "What is the effect on the acidity and buffering action of the initial thawed juice?" Reported here is an *in vitro* analysis of the acidity and buffering capacity of fruit juices at room temperature, compared with data of liquid drawn from the initial thaw of frozen fruit juices.

MATERIALS AND METHODS

Liter cartons of 100 percent pure commercially available fruit juices were purchased at different times at different retail outlets over a period of six months. The fruit juices had no sugar or preservatives added and were pure juices or constituted by blending clarified, unflavored apple or grape juice with the dominant flavoring fruit. Strawberry, apricot, pear, granadilla, grape, peach, orange, apple and black-currant juices were tested. The cartons were allowed to stand on the bench to equilibrate to room temperature (25°). Each carton was shaken for fifteen seconds, 100 ml of the juice poured

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into a 250 ml beaker and the pH determined using a standardized, single calomel electrode radiometer, pH meter.

The juice was titrated against 1N NaOH by adding 0.5 ml NaOH to the juice, mixed well and the pH determined. The process was repeated until a pH of 10 was reached. This was done with six different cartons for each juice. Means and ± standard deviations were determined for the amounts of NaOH used at progressive states of pH.

The carton containing the remainder of each of the juices was sealed and placed in a -20°C deep freezer for twenty-four hours. The cartons were then removed and allowed to defrost. The first 100 ml of defrosted "juice" were poured into a 250 ml beaker, allowed to equilibrate to room temperature (25°C) and the pH determined. Titration of 0.5 ml of 1N(NaOH) solution was titrated and pH recorded as described above. The means ± standard deviations were determined. XY Titration curves were plotted for each juice before and after freezing (Figures 1 and 2).

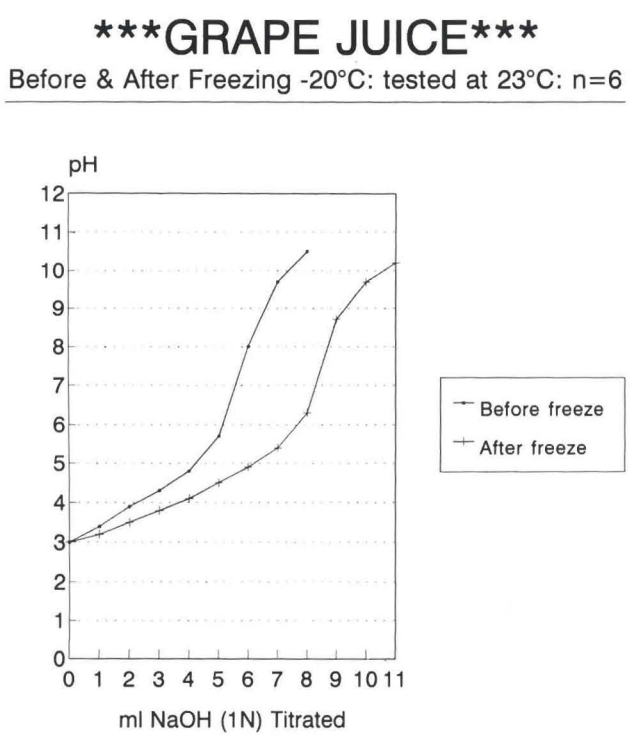
RESULTS

All the fruit juices recorded pH measures below pH = 3.5. All the room temperature fruit juices needed less NaOH titration to reach pH than did the corresponding frozen fruit juices. The amounts of lN NaOH recorded to reach pH = 5.00, pH = 5.5 and pH = 10 were all more for frozen fruit juice than room temperature fruit juice alone, and the differences were highly significant ($p<0.01$) at pH = 5, pH = 5.5 and pH = 10 ($p<0.001$. Student-t test).

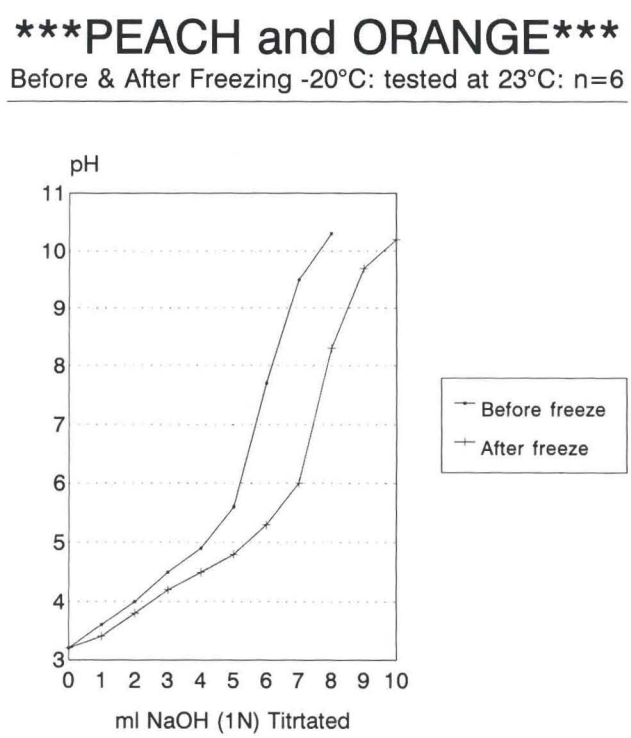
The graphs of all the juices followed a similar progression curve i.e., they all showed no significant difference of pH at the initial reading, but diverged significantly as the pH increased against the amount of 1N NaOH required to raise the pH to pH = 5.5 and pH = 10 (Figures 1 and 2).

DISCUSSION

Since the buffering capacity is proportional to caries activity, and a drop in intraoral pH is considered the



No Significant Difference initially at pH=3; Student-t Test
Significant Difference at pH=5 & pH=5.5 $p<0.01$; & pH=10: $p<0.001$
FIGURE 1



No Significant Difference initially at pH=3.2; Student-t Test
Significant Difference at pH=5 & pH=5.5 $p<0.01$; & pH=10 $p<0.001$
FIGURE 2

prime etiological factor in initiating decalcification, erosion or decay, ingestion of the frozen fruit juice can be considered as potentially highly destructive to teeth.[6,16-19] The recorded pH and buffering capacity of the room temperature fruit juice confirms published results; but the increase in buffering capacity of the initial thawed liquid, strongly suggests that sucking frozen fruit juices could be more erosive than unfrozen fruit juice, and would require more than the usual volume of alkaline salivary buffering to raise and normalize the oral environmental pH.[3,5,6]

Ice cream is a product of dairy-products, whereas iced-confection uses food sources other than dairy-products in the manufacture of frozen edibles. Using fruit juice as a fundamental source for iced-confection is thus not without hazards. Just as abuse of fruit juice consumption is acknowledged as hazardous to teeth, so too regular eating and sucking frozen fruit juice could be equally, if not more, hazardous to calcified tooth structure.

Disregarding the remaining ice-cone skeleton of the sucked-out fruit lolly aggravates the situation as the fruit acids are concentrated, and the diluting effect on the acid, by the melting ice, is diminished.

Dietary acids (like citric acid in citrus, malic acid in apples, and tartaric acid in grapes) have pH measures all less than pH = 3, and their ingestion decreases the pH of plaque and oral environment.[6] Should the intrinsic buffering capacity of an acid mixture, such as fruit juice, be increased, the direct extrapolating proposition is made that it would take more alkaline salivary flow to neutralize its effect in the mouth. Since children are frequently involved in the consumption or active motivation in acquiring the frozen fruit juices, pediatricians, pediatric dentists, dental hygienists, general dentists, children's nursing staff, teachers, parents and all other child health-care providers should take cognizance of this new trend of consuming frozen fruit juice, and caution against or strongly discourage this form of consumption as a frequent habit.

CONCLUSION

Acid buffering capacity of fruit juice is increased by freezing, and iced confection based on fruit juice is potentially detrimental to teeth.

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ABSTRACTS

Pinkham, Jimmy R.: The roles of requests and promises in child patient management. J Dent Child, 60:169-174, May-June 1993.
The most basic determinant of a dentist managing a young child during a dental appointment is the ability of the dentist to make effective requests of the child to cooperate. In some instances these requests can be very subtle and even nonverbal. In other instances they must be made more assertively. This basically means more dramatically. When children misbehave during a dental appointment, what in reality they are doing is denying the request to cooperate by the dentist. Children who are misdirected, i.e. have a misdirected goal of childhood, may find the ability to respond effectively to requests to be compromised. In conclusion, the child's specific misdirected goal and his allegiance to a misdirected goal have a great deal to do with how easily he can be managed by traditional applied psychological techniques in pediatric dentistry.
Requests; Promises; Patient management

Veerkamp, J.S.J.; Gruythuysen, R.J.M.; W.E. van Amerongen; Hoogstraten, J.: Dental treatment of fearful children using nitrous oxide. Part 3. Anxiety during sequential visits. J Dent Child, 60:175-182, May-June 1993.
This study is part of a larger project, focusing on the utility of nitrous oxide in the dental treatment of highly fearful children. The objective of this study is to determine the effects of nitrous oxide in comparison with behavioral management. The behavior of 55 children randomly allocated to these conditions was videotaped, therefore, during sequential dental visits and subsequently compared. Results show that nitrous oxide is an effective aid in the treatment of phobic child dental patients, but merely in the earliest sessions of this treatment. In the long run behavioral management alone seems to be just as effective. Based on a covariant analysis, it is advised not to use filmed observations for children aged above 8 years.
Nitrous oxide; Phobic children; Filmed observation

Jedrychowski, Joseph R.; Duperon, Donald F.: Effectiveness and acceptance of electronic dental anesthesia by pediatric patients. J Dent Child, 60:186-192, May-June 1993.
Previous studies have demonstrated the success of Electronic Dental Anesthesia [EDA] as a substitute for injectable local anesthesia. The purpose of this clinical trial was to determine the efficiency and acceptance of EDA when utilized for pediatric patients. Forty patients ranging in age from three to twelve years of age participated. Approximately one half had received local anesthesia by injection at previous visits; the remainder had never experienced local anesthesia. Procedures performed were amalgams, composites, stainless steel crowns, and anterior composite crowns. Fewer than 5 percent of patients experienced moderate discomfort during treatment. EDA was successful with all other patients. All patients accepted EDA without hesitation. All patients who had previously experienced local anesthesia by injection expressed a preference for EDA during future appointments.
Pediatric local anesthesia; Electronic dental anesthesia; EDA; Pain control

Foreman, Frank J.: Effects of delegation, state practice acts, and practice management techniques upon sealant utilization: A national survey of pediatric dentists. J Dent Child, 60:193-200, May-June 1993.
Delegation of sealant placement has been set forth as a means to increase access to sealant care and its cost effectiveness. Recommendations have been made to broaden state practice acts to include sealant placement by auxiliaries. A geographically balanced survey was sent to four hundred pediatric dentists in all fifty states concerning their practice and sealant utilization. Two hundred and sixty-five surveys were returned. The results of survey found that: 1) delegation of sealant placement did increase sealant usage, but also increased its cost, 2) access to sealant care was maintained in small practices without delegation, but could only be maintained efficiently in large practices by delegation, 3) State Practice Acts that allow delegation only to hygienists decreased legal sealant delegation by 27.5 percent, 4) cotton roll isolation was preferred, 5) regional differences in sealant prevalency was not reflected in pediatric dental usage, and 6) sealant placement was felt to be extremely safe.
Sealant placement, delegation of; Auxiliaries

Hicks, M. John; Flaitz, Catherine M.; Westerman, Gary H. *et al*: Caries-like lesion initiation and progression in sound enamel following argon laser irradiation: An *in vitro* study. J Dent Child, 60:201-206, May-June 1993.
The purpose of this *in vitro* study was to evaluate the effect of argon laser irradiation (231 milliwatts for 10 seconds) on caries-like lesion initiation and progression in human enamel. Windows of sound enamel were exposed to a single argon laser treatment (231 milliwatts, 12 Joules/cm^2) for 10 seconds and caries-like lesions were created using acidified gel. Following lesion initiation, mean body of the lesion depth was significantly less ($p<0.05$) for argon lased surfaces (69um) when compared with paired, control surfaces (117um). Following the first lesion progression period, mean body of the lesion depths were 103um for argon lased surfaces and

158um for control surfaces ($p<0.05$). Following the second lesion progression period, mean body of the lesion depth was significantly less ($p<0.05$) for argon lased surfaces (135um) when compared with paired, control surfaces (221um). Incremental increases in body of the lesion depths were 34um for argon lased surfaces compared with 41um for control surfaces following the first lesion progression ($p<0.05$), and 66um for argon lased surfaces compared with 104um for control surfaces following the second lesion progression ($p<0.05$). Laser irradiation resulted in an overall reduction of 41 percent in mean lesion depth. Exposure of sound enamel surfaces to argon laser irradiation significantly enhances the resistance of lased sound enamel to an *in vitro*, continuous cariogenic challenge.

Enamel caries; Argon laser; Artificial caries

Nunn, June H.: Eruption cysts: A cautionary tale. J Dent Child, 60:207-209, May-June 1993.

Two cases are presented of young children presenting with lesions that clinically appeared as eruption cysts. The management of the two cases is described.

Eruption cysts; Pyogenic granuloma

Aine, Liisa; Baer, Maija; Mäki, Markku.: Dental erosions caused by gastroesophageal reflux disease in children. J Dent Child, 60:210-214, May-June 1993.

The teeth of seventeen children (median age 8.1 years) with gastroesophageal reflux disease (GER) were studied for dental erosions. Erosive lesions were found in thirteen out of fifteen children (87 percent) with known GER. In two children dental erosions led to GER diagnosis. All the lesions were of the same type, but of different grades. The most typical alterations were small holes on occlusal surfaces of primary molars. In more severe form the dentin was also involved. Both primary and permanent incisors showed etched appearance. According to these findings a new classification was created, which takes into account the severity of erosive lesions caused by GER both in primary and permanent teeth. Children with confirmed GER should have their teeth routinely checked. Dental erosions of the type described here can be regarded as an indicator of clinically important manifest or silent GER. Children with such lesions should be sent for pediatric consultation, including long-term esophageal pH recording.

Erosion, dental; Gastroesophageal reflux disease

H. Barry Waldman: The health of our children and their use of medical services. J Dent Child, 60: 215-219, May-June, 1993.

In an effort to provide pediatric dental practitioners with a greater awareness of the health status of youngsters in our communities, data (from government and insurance agency reports) are presented on the illnesses of children and their use of health services.

Health status, awareness of; Pediatric dentists

H. Barry Waldman: Increasing enrollment of very young children in educational programs. J Dent Child, 60:220-222, May-June 1993.

Increasing numbers of very young children are being enrolled in nursery and kindergarten programs. As a result, pediatric dentists will be providing care to children with a very different set of experiences. Demographic characteristics of this population are reviewed.

Educational programs; Enrollment; Nursery and kindergarten

L.Z.G. Touyz and M. Silove: Increased acidity in frozen fruit juices and dental implications. J Dent Child, 60:223-225, May-June 1993.

Acidic (pH ≤ 3.5) fresh fruit juices (FJ) have buffering capacities that overwhelm neutralizing saliva, prolong intraoral low pH, and cause decalcification and erosion. Frozen fruit juices (F_2FJ), produced commercially or domestically, are consumed as iced confection. Data on acidity and buffering of frozen fruit juices are rare. Reported here are measurements of pH and buffering capacities of fruit juice and initial defrosted liquid of frozen fruit juice. Pure fruit juice mixtures were tested ($n=6$ for each: no added sugar or preservatives: clarified unflavored apple or grape juice blends with strawberry, granadilla, grape, peach and orange, pear and apricot). A hundred ml sample of each fresh fruit juice was measured for pH and titrated against NaOH; the pH was determined to pH 10. The solid frozen fruit juice (-20°C for 24 hours) was thawed and the first melted 100 ml measured for pH, and similarly titrated with NaOH for buffering capacity (at 23°C to pH 10) — $n=6$ for each measure of each mixture of fresh fruit juice and frozen fruit juice. Results showed all fresh fruit juices and frozen fruit juices initial pH values below 3.5 and no significant differences between them (Student-t test: $p<0.9$). The frozen fruit juices all had significantly increased buffering capacities between pH 5.0 to 5.5 and pH 10 ($p<0.01$). Since enamel decalcifies at pH 5.0 to 5.5, frozen fruit juice with its low pH and increased buffering capacity may be extremely erosive to teeth.

Frozen fruit juices; Dental erosion