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AMERICAN SOCIETY OF DENTISTRY FOR CHILDREN
JOURNAL OF DENTISTRY FOR CHILDREN
NOVEMBER–DECEMBER 1993

In recent years Masterson and Offer provided evidence suggesting that the turmoil-ridden adolescent is a disturbed adolescent and that most young people negotiate the high school years with no major disruption of personality.

That this is the case does not, of course, minimize the stresses of the mid-adolescent period; it suggests, rather, that most young people have at their disposal a system of defenses and coping capacities that enable them to weather these stresses. It is well known, however, that a significant number cannot do so.

The vulnerable adolescent faced with such threats may break down completely, evidencing an acute psychotic disorder which may, or in rare cases may not, be the prelude to long-term schizophrenic illness. In order to maintain a semblance of integrity, however, he will more frequently protect his tenuous psychic structure by withdrawing into a schizoid isolation.
— Aaron Esman

FORTUNATELY [PSYCHO]ANALYSIS IS NOT THE ONLY WAY TO RESOLVE INNER CONFLICTS. LIFE ITSELF STILL REMAINS A VERY EFFECTIVE THERAPIST.

—*Karen Horney*
Our Inner Conflicts (1945)

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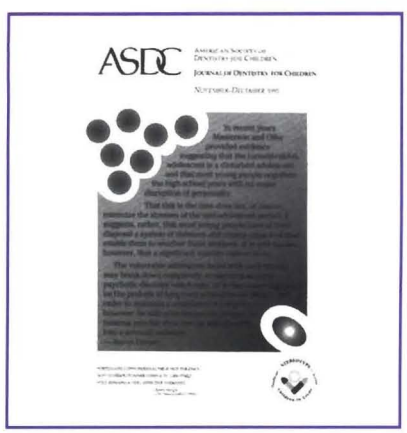

Most young people come through their adolescent years with no major disruption of personality. They use successfully a system of defenses and coping capacities that enable them to weather the stresses.

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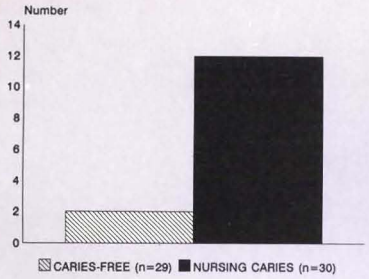

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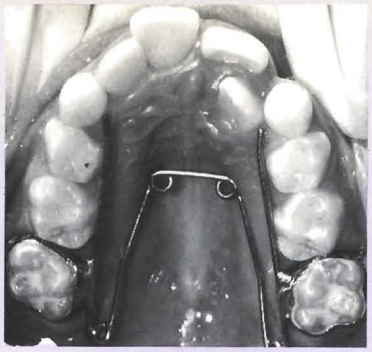

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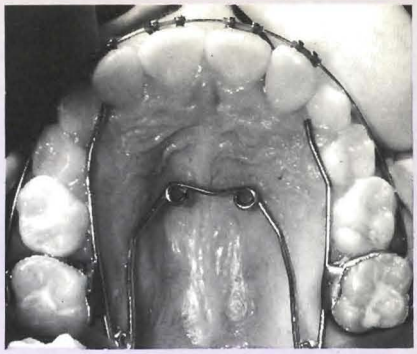

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ABSTRACTS

Jessee, Stephen A.: The neglect of our youth: A dental perspective. J Dent Child, 60:361-364, November-December 1993.

Although child abuse has received much well-deserved media attention in recent years, neglect, the other component of child maltreatment is still misunderstood and underreported. Societal problems such as poverty and increased substance abuse among already dysfunctional families have increased the chance of neglect occurring. The signs and symptoms of dental neglect, a form of medical neglect, are discussed. It is sometimes difficult for the dentist to distinguish between ignorance of dental disease and overt negligence on the part of a parent. It is hoped that, more dentists will get involved in combatting not only dental neglect, but all forms of neglect as well.

Child abuse; Child neglect; Societal problems

Friedlander, Arthur H.; Freymiller, Earl G.; Yagiela, John A.; Eth, Spencer: Dental management of the adolescent with panic disorder. J Dent Child, 60:365-371, November-December 1993.

Panic disorder is a psychiatric disease without obvious cause. It is accompanied by signs of terror, such as chest pain, palpitation, and shortness of breath. One of every 75 Americans is afflicted. Onset occurs most commonly during adolescence. Some infants and children exhibit anxiety-like responses, such as retreat and avoidance, and behavioral restraint when faced with unfamiliar people, objects, and events. Panel disorder has a special relevance for dentistry, because it is frequently associated with mitral valve prolapse. Furthermore, medications used to treat the disorder are associated with detrimental changes in the oral cavity and adverse interactions with dental therapeutic agents.

The authors discuss the podromal characteristics of children at risk for panic disorder and the characteristics of the malady recognized by the American Psychiatric Association. Associated medical problems are also presented and discussed.

A survey of ninth graders found as many as 12 percent had spontaneous panic attacks. Approximately 20 percent of all adults with the disorder report its onset before age ten.

Etiology, medical and dental management are discussed.

Panic disorder; Etiology; Management

Veerkamp, J.S.J.; Gruythuysen, R.J.M.; Hoogstraten, J.; van Amerongen, W.E.: Dental treatment of fearful children using nitrous oxide. Part 4: Anxiety after two years. J Dent Child, 60:372-376, November-December 1993.

Nitrous oxide is considered to be most effective for treating moderately fearful children. Recent research shows even highly anxious children become less fearful, virtually immediately when it is used. The authors were interested in learning more about the permanency of its effect. The answers to the questions pertaining to permanency are important as to whether drug-based supporting treatment strategies are necessary, or whether behavior modification techniques are adequate.

For the comparison with behavioral management, the age chosen was the youngest age possible that would permit communication with the dentist.

Fifty-five highly fearful children, between the ages of six and eleven years and who were enrolled in normal primary education were selected. The subjects were placed randomly in one of two groups, one to be treated with behavioral management only (control) and the other with behavioral management and nitrous oxide sedation (experimental group).

The measuring instrument described by Venham and modified for this study was used to conduct the evaluation. Conclusions are significantly positive for using nitrous oxide.

Fearful children; Nitrous oxide; Long-term benefits

Juambeltz, Jose C.; Kula, Katherine; Perman, Jay: Nursing caries and lactose intolerance. J Dent Child, 60:377-384, November-December 1993.

Caries is associated with fermentable carbohydrates in the diet. Dietary content can be related to personal and cultural preferences, availability of food, or physiologic tolerances. Twenty-seven percent of black children ages 12 to 24 months, in the Baltimore area were reported with symptoms of lactose intolerance. The incidence of lactose intolerance increased to 33 percent by age six years. At the same time, clinical observations of this same population suggested a high prevalence of nursing caries. One purpose of this study was to determine whether parents of black children with nursing caries perceived in their children more severe symptoms of lactose intolerance, which they related to milk products, than did parents of caries-free black children. A second purpose was to determine whether there were differences in feeding habits and types of fluids given children with nursing caries compared with caries-free children.

A questionnaire concerning symptoms consistent with lactose intolerance, feeding habits, and fluid-selection was administered to the following groups: parents of 30 black children, ages 18 to 54 months, who were caries-free and parents of 30 black children, ages 18 to 54 months, diagnosed with nursing caries. Chi-square analysis or t-test analysis were performed on results accepting $p < 0.05$ as significant. The results showed that children with nursing caries as compared with caries-free chil-

dren: 1) were put to bed with the baby bottle significantly more often; 2) showed a tendency to be kept on the baby bottle for a longer period; 3) received other fluids significantly more often than milk; and 4) showed a tendency toward significantly greater scoring of symptoms that parents associated with milk or milk-product ingestion.
Nursing caries; Lactose intolerance

Johnson, Eric D. and Larson, Brent E.: Thumb-sucking: Literature review. J Dent Child, 60:385-391, November-December 1993.
A multidisciplinary literature review of nonnutritive-sucking habits is presented. The causes, prevalence, and risks of these habits are discussed, and factors that contribute to the severity of the habit are identified.
Nonnutritive sucking habits; Literature review, multidisiplinary

Johnson, Eric D. and Larson, Brent E.: Thumb-sucking: Classification and treatment. J Dent Child, 60:392-398, November-December 1993.
A new classification and treatment scheme is described that allows practitioners easy classification and appropriate treatment of a wide variety of nonnutritive-sucking habits. Summary classification and treatment reference tables are provided for convenient clinical reference.
Nonnutritive sucking habits; Classification; Treatment

Waldman, H. Barry: Twenty-five years of increasing use of pediatric dental services. J Dent Child, 60:399-402, November-December 1993.
Data from a continuing series of surveys by the national Interview Survey confirm further increases in use of pediatric dental services through 1989. The surveys show that by 1989 almost a third of children between two and four years of age visited a dentist in the previous year. For children between two and fourteen, and between five and fourteen, 60.5 percent and 69.5 percent, respectively, had visited a dentist in the previous year.
Most significant has been the decrease in the percent of children who never visited a dentist, in the past twenty-five years. In the mid 1960s, approximately a quarter of children between five and fourteen years had never visited a dentist. Twenty-five years later, the percentage was reduced to 8.6 percent. There were also decreases in the percent of very young children (less than five years and between two and four): 78 percent and 55 percent, respectively, in the 1980s.
There are, however, major reasons for concern. The percentage of children living in poverty continued to increase in the 1990s. In 1990 cases of measles, mumps, rubella, and pertussis increased. Twenty-two countries had lower infant mortality rates than the U.S. Increasing rates of nursing caries and fluorosis are appearing.
Pediatric dental services; Dental visits; Concerns

Waldman, H. Barry: More minority children and the need to stress dental care. J Dent Child, 60:403-407, November-December 1993.
Dramatic changes in population projections through the middle of the next century indicate major increases in the size of the population, particularly for the various minority groups. For the most part, these are the populations which traditionally have had greater dental needs and reduced levels of services. The future of pediatric dentistry will required increased attention to these populations.
Population increases; Minority groups; pediatric dentistry

Henry, Robert J.: Slow maxillary expansion: A review of quad helix therapy during the transitional dentition. J Dent Child, 60:408-413, November-December 1993.
The maxillary quad-helix appliance is a commonly used approach for treatment of maxillary arch constriction and/or posterior crossbite. Concern over excessive force generation during rapid maxillary expansion led to its development and use in growing children. The purpose of this article is to present the clinical application and therapeutic considerations regarding use of the quad-helix appliance in the slow maxillary expansion of mixed dentition cases. Considerable evidence is presented supporting such early expansion and factors for case selection are identified when considering this a treatment option.
Maxillary expansion, slow; Quad-helix therapy

NEGLECT

The neglect of our youth: A dental perspective

Stephen A. Jessee, DDS

Child maltreatment consists of two main components: abuse and neglect. Much of the recent attention given this subject has focused primarily on abuse, both physical and sexual, due to the visually demonstrative results of such deplorable acts. Neglect, on the other hand, has not seemed to inspire the same degree of indignation or disgust even though it accounts for approximately 40 percent of child maltreatment fatalities and over a half of all cases reported to Child Protective Service agencies.[1,2]

Dental neglect, as an adjunct, is ignored to a greater degree even in its most severe forms. In many states, dental neglect is still not recognized within the context of medical neglect. It is the purpose of this paper to increase and improve the information presented to dental professionals about the signs and symptoms of dental neglect, in the hope that more of us will come to the aid of children affected by this malady.

DEFINITION

Neglect can be defined as the negligent treatment of a child, including failure to provide adequate food, clothing, or medical treatment. Unlike abuse, neglect is not the result of individual actions, but rather the chronic ineffectiveness or absence of the parent or guardian. Simply put, neglect is an act of omission.[3]

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The American Academy of Pediatric Dentistry defines dental neglect as the "failure of a parent or guardian to seek and obtain appropriate and available treatment for caries, oral infections, or any other condition of the teeth and supporting structures that:

1. Makes routine eating difficult or impossible
2. Causes chronic pain
3. Delays or retards a child's growth or development

or

4. Makes it difficult or impossible for a child to perform daily activities such as playing, working, or going to school."[4]

Since dental health is an acknowledged part of one's overall medical status, dental neglect should be considered within the same category as medical neglect. Although its results might not be as visible or life threatening when compared to those of severe medical neglect, the effects of dental neglect should be a genuine and valid concern.

ETIOLOGY OF NEGLECT

Societal Problems

All parents have committed neglectful behavior at various times in the course of rearing a child, but certain

Poverty

families are at greater risk for neglect to occur. Neglect has long been associated with poverty. Our society has

an unusually large number of families living in poverty with limited funds allotted to support them.[5] Regardless of the wishes of the parents, if the means to supply the "necessities of life" are not available, neglect, in some form, will occur. This statement is not meant to convey the idea that being poor, alone leads to neglect of one's children.[6] Many families living in poverty rear children in a loving and nurturing environment. It is the family, already internally dysfunctional, that succumbs to neglect with the addition of further unmanageable stress.

The increased incidence of substance abuse has a two-fold effect on neglect. Not only does it deplete the

Substance abuse

economic resources available to the child, but also leaves the child both physically and psychologically unsupported, while the parent(s) are under the drug's influence.[5,7] Substance abuse by middle class parents, when taken as an isolated factor, has led to increased reports of neglect within this specific segment of society.[6]

Parental Characteristics

A major underlying cause of child neglect can be found in certain personality difficulties and deficiencies of the

Parents

parents.[5,6,8-10] The following composite of neglectful parents or guardians may help dental professionals to understand and relate to the clinical manifestations of neglect:

- ☐ Young, single female head of household with little or no support.
- ☐ Depressed, hostile, resistant to change.
- ☐ Substance abuse.
- ☐ Low self-esteem.
- ☐ Poorly educated or overtly retarded.
- ☐ Psychologically or physically ill.
- ☐ Economically disadvantaged.
- ☐ Child-like, often competing with children for attention.

Two conditions, which act to coalesce the above characteristics, play a major role when contemplating why some parents are neglectful and others, with similar circumstances, are not. One condition is the cycle of neglect and the other is lack of empathy for the child.[8,9] A history of neglect (and abuse) in the formative years of a neglecting parent is likely responsible for his/her inability to empathize adequately with a child.[8]

The relationship between substance abuse and child maltreatment should not be overlooked. Children of alcoholic mothers and fathers are three to eight times, respectively, more likely to be abused or neglected than children from nonalcoholic households.[11]

CLINICAL FINDINGS

For dentists to be able to recognize and diagnose neglect they should be cognizant of the signs and symptoms of not only dental neglect, but neglect in general. A list of both physical and behavioral indicators follows.

General Neglect

PHYSICAL SIGNS

- ☐ Constant hunger.
- ☐ Lack of supervision.
- ☐ Fatigue or listlessness.
- ☐ Unattended medical needs.
- ☐ Poor personal hygiene.
- ☐ Inappropriate or inadequate clothing.
- ☐ Small stature with respect to age.

BEHAVIORAL SIGNS

- ☐ Begging, stealing food.
- ☐ Inappropriate school attendance.
- ☐ Engages in delinquent acts.
- ☐ Constantly falling asleep.
- ☐ Alcohol or drug abuse (addiction).[12-15]

Dental Neglect

The diagnosis of dental neglect when compared to general neglect is a somewhat more difficult task. Sometimes financial, intellectual and societal obstacles must be considered before a final (reportable) diagnosis is made.[16] Davis *et al*, noted the following indicators of dental neglect:[17]

- ☐ Untreated rampant caries easily detected by a lay person.
- ☐ Untreated pain, infection, bleeding, or trauma affecting the orofacial region.
- ☐ History of a lack of continuity of care in the presence of identified dental morbidity.[17]

Other intraoral and extraoral findings, although not

constituting dental neglect, might be of benefit to the affected child, if corrected. Included among these are severe malocclusions, abnormal tongue positions, cleft palate or lip, missing teeth, or other esthetic malformations.[18] Problems that have resulted or may result in speech or eating disorders should also be addressed. If, after gathering all diagnostic evidence, it is decided that a neglectful situation is the result of ignorance of the dental problem and not a blatant disregard for the child's welfare, the parent or guardian might be receptive to not only suggestions for treatment of the obvious dental disease, but for correction of any of the above mentioned abnormalities.

Although most neglect can be attributed to such societal problems as poverty and isolation, when oral problems have been diagnosed and necessary treatment clearly explained, when financial and transportational obstacles have been eliminated, the ineffectiveness of a parent to see that all necessary care is provided is nothing less than neglect.[19] As with all areas of child maltreatment, dentists are mandated to report dental neglect. The purpose of reporting is to assist the family in overcoming its difficulties, thereby allowing the child to receive needed dental treatment. Failure to do so can result in a civil or criminal lawsuit filed against the dentist for negligence and the levying of substantial fines.[20] It is not uncommon for health professionals to focus their empathy solely on the affected child and lose sight of the family. This can result in an overt expression of anger toward the parent, which is extremely unproductive. Including the entire family in one's concern will probably facilitate a more cooperative response from the parent(s).

CASE HISTORY

A dentist, employed by a large southwestern metropolis at one of its dental clinics, upon examination of a nine-year-old male for an emergency situation, noted gross, extensive decay present in all first permanent molars. Most of the remaining primary dentition was also severely decayed. When questioned about her son's condition, the mother stated that she was aware of his problem, but had no way to pay for treatment or transportation to see a dentist on a regular basis. The dentist informed the mother that he and the clinic would assist her in any way needed, and assure that her son's necessary dental treatment was completed. The required emergency treatment was performed, all future treatment explained, and the child was reappointed approximately two weeks later. Transportation to and from the clinic for all subsequent appointments was arranged through a local volunteer agency.

The child did not appear at the appointed time and the clinic was unable to reach the mother to schedule another appointment. Six months later, the same child was brought to the clinic with a severe mandibular swelling, which required extraction of the affected tooth. When asked why she had not kept her son's previous appointment, the mother again cited financial and transportational problems. It was clear to the dentist that the mother was negligent with regard to her son's dental needs and a report was filed with Child Protective Service (CPS). Eventually, through the collaborative efforts of CPS and the clinic, the child's dental treatment was completed.

This case clearly conformed with Davis' indicators for dental neglect, previously mentioned. The disease had been identified, treatment had been explained and understood, and all obstacles had been removed. For the parent to not follow through with the necessary treatment constituted not only a disregard for the child's well-being, but also, obvious dental neglect.

CONCLUSION

In 1991, almost 2.7 million children were reported as suspected victims of child maltreatment.[1] Of this figure, well over half were attributed to neglect. When considering further that many reporting agencies list only the primary allegation for each case (either abuse or neglect) and that in many instances, neglect is an unfortunate and sometimes silent partner of abuse, the percentage of reported cases of child maltreatment attributed to neglect is probably grossly underestimated. This same theory more than likely holds true for dental neglect as well.

As stated by the U.S. Advisory Board on Child Abuse and Neglect in its 1991 report:

Family life has become increasingly diverse and complex, and young families and families headed by women are increasingly and disproportionately subject to economic and social stresses.[7] The results of this trend are impacted on the lives of our youth in the form of physical, emotional and intellectual developmental deficiencies.

Dental professionals have the obligation to keep themselves educated and up-to-date on all aspects of child maltreatment. Neglect, as the most underdiagnosed component of maltreatment, needs our attention to an even greater degree. Child neglect cannot be ended by mere treatment alone. Prevention, as-

sisted through early diagnosis and reporting by all health professionals, is what is needed to help put an end to the cycle of neglect.

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PRENATAL EXPOSURE TO ILLEGAL DRUGS

Every day in America, more than a thousand babies are born, like Kenya's firstborn son, exposed to illegal drugs in the womb. Some infants clench tiny fists and writhe in withdrawal from stimulants; others lie drugged and despondent from narcotics. Many suffer permanent brain, liver, kidney, heart, and lung damage or are twisted with terrible deformities because their mothers shot, sniffed, smoked, or drank to excess. A congressional committee estimated that in one year (1988) of the crack epidemic, 375,000 babies were exposed as fetuses to illegal drugs—that is one in eleven American babies whose basic human rights to healthy development are violated before birth. Over the course of a decade, this means that nearly 4 million American babies will begin life disabled to some degree by drugs—babies who will have to carry this burden for a lifetime as they struggle to achieve critical stages of development.

Freedman, J.: *From cradle to grave.*
New York: Atheneum, 1993, p 12.

BEHAVIOR

Dental management of the adolescent with panic disorder

Arthur H. Friedlander, DDS
Earl G. Freymiller, DMD, MD
John A. Yagiela, DDS, PhD
Spencer Eth, MD

Panic disorder (PD) is a psychiatric disease characterized by recurrent surges of severe anxiety without obvious cause. The accompanying physical signs of terror, such as chest pain, palpitation and shortness of breath, are perceived as life-threatening. The disorder is relatively common, afflicting one out of every seventy-five Americans during their lifetime. Onset of the panic attacks most commonly occurs during adolescence. Before developing the florid symptoms of PD some infants and children exhibit a number of anxiety-like responses, such as retreat and avoidance and behavioral restraint when faced with unfamiliar people, objects, and events. Panic disorder has special relevance for dentistry because it is often associated with mitral valve prolapse, a condition that may require endocarditis prophylaxis during bacteremia-provoking procedures. In addition, the medications most often used to treat PD are associated with detrimental changes in the oral cavity and adverse interactions with dental therapeutic agents.

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The authors would like to acknowledge the editorial assistance of Ms. W. Emerson.

PRODROMAL CHARACTERISTICS OF CHILDREN AT RISK FOR PANIC DISORDER

A subgroup of the very young children who are destined to develop panic disorder in late childhood or adolescence will display subtle signs of disturbed development from infancy, although not all children with these characteristics will develop PD.[1-6] These youngsters are often described as being extremely shy, inhibited, introverted, and withdrawn. When exposed to unfamiliar people, objects, and events, they cease playing and talking, retreat, and seek comfort from a familiar figure (i.e., cling to their mother). As they get older, they remain vigilant and cautious in novel situations (strangers, crowds, elevators, plane travel, going outside alone, and being upstairs and home alone). When they reach school age they may become excessively fearful and manifest separation anxiety, performance

anxiety in class, and "school phobia" or school avoidance. Their level of anxiety may be so great as to interfere with normal peer relations.

CHARACTERISTICS OF PANIC DISORDER

Panic disorder is classified by the American Psychiatric Association as a mental illness.[7] Panic attacks, the hallmark of the disorder, are spontaneous and unexpected episodes of intense fear (typically lasting 30-45 minutes) accompanied by chest pain, rapid pulse, palpitation, shortness of breath, sweating, nausea, and feelings of unreality and detachment.[8-10] During initial attacks individuals usually misinterpret the physical sensations and cognitive symptoms and believe that they are having a fatal heart attack or are going crazy.

At first these attacks tend not to be triggered by fear-provoking situations, such as elevators, snakes, dentists, or public speaking. Later in the course of the illness, however, many of these individuals begin to associate certain situations (being alone, leaving home, entering crowded areas such as school classrooms, movie theaters, and public transportation) with having a panic attack. Persistent apprehension of having another attack in the form of anticipatory anxiety interferes significantly with quality of life as these individuals feel it necessary to avoid these situations, and restrict their social activities.[11] They are often unable to travel or even leave home without a companion or elaborate reassurances regarding their safety (agoraphobia). Unabated, these attacks lead to hypochondriacal fears, beliefs, and behaviors, demoralization ("reactive depression"), and numerous visits to a series of physicians in effort to gain relief.[12,13]

Associated Medical Problems

Mitral valve prolapse (MVP) is an accompanying physical condition in approximately 35 percent of patients afflicted with PD.[14-16] The co-occurrence of PD and MVP is of unique importance in dentistry because individuals with this cardiac lesion are at increased risk of developing endocarditis after a bacteremia-producing dental procedure.[17]

Panic disorder is also associated with other health and social impairments. In prepubertal children and very young teenagers it is often seen in association with multiple somatic complaints (e.g., "blackout spells", breathing problems, abdominal pain and cramping, diarrhea, urge to defecate, migraine headaches, and dizziness).[18-21] In older teenagers and young adults there is an increased risk of major depression, alcohol and illicit substance abuse, excessive use of prescription psychotropic medications, and suicidal ideation and suicide attempts.[22,23]

Epidemiology

The lifetime prevalence of PD in the general population is 1.5-2 percent.[24] The peak age of onset is fifteen to nineteen years; however, it does occasionally occur in younger adolescents and prepubertal children.[25-30] A survey of ninth graders found that as many as 12 percent had spontaneous panic attacks.[31] Approximately 20 percent of all adults with PD report its onset before age ten.[32] In all age-groups, females are two to three times more likely than males to have the disorder. The prevalence of PD decreases with age beginning in middle age.[33]

Panic attacks, the hallmark of the disorder, are spontaneous and unexpected episodes of intense fear.

Etiology

A familial and genetic pattern for this disorder has been noted, although investigators have yet to discover the specific mode of intergenerational transmission. The first-degree relatives of individuals with PD have markedly elevated rates (approximately 30 percent) of the disorder. Monozygotic twins are five times more likely to be concordant for panic attacks than dizygotic twins.[34] Controlled studies have shown that patients with PD experience significantly more stressful life events (death or illness of a parent, familial conflict, personal physical illness, stress at school, family move) in the six months before its development than matched control groups.[35-36] This finding suggests that psychosocial factors and environmental stress may precipitate the expression of an underlying biologic (genetic) vulnerability.

The exact mechanisms responsible for the production of a panic attack remain unknown, but converging lines of evidence implicate the locus ceruleus. Some investigators believe that the locus ceruleus (the brain's major noradrenergic nucleus residing in the pons) "spontaneously" and in an "unprovoked manner" releases massive amounts of norepinephrine. This results in excessive sympathetic nervous system stimulation that contributes to the physical and cognitive symptoms of PD including increase in the rate and force of cardiac contractions, rapid breathing and anxiety. Heightened awareness and an ominous and menacing misinterpretation of these intensely unpleasant sensations (such as, "I'm having a heart attack") results in a panic attack.[37] A significant number of researchers do not accept the theory of "unprovoked" production of norepinephrine. They believe that susceptible individuals unconsciously misperceive the environment as threatening, and that it is these fearful thoughts that trigger a hyper-reactive stress response and massive secretion of norepinephrine by the locus ceruleus.[38]

It has been shown experimentally that panic attacks can be induced in those afflicted with PD by caffeine ingestion (the amount contained in one cup of coffee), inhalation of carbon dioxide, and an infusion of sodium lactate.[39-41] Sodium lactate, through a series of metabolic reactions, releases carbon dioxide, which crosses the blood-brain barrier, stimulates the locus ceruleus, and triggers a panic attack.

Regional cerebral blood flow studies of individuals with PD demonstrate hyperperfusion and increased metabolism of the right parahippocampal region of the brain. These abnormalities are consistent with increased neuronal activity of the locus ceruleus, whose terminal axons project into and innervate this region.[42]

Peak age of onset is 15 to 19 years.

Panic disorder and MVP have a similar constellation of symptoms (chest pain and palpitations) and frequently co-occur. There does not appear to be a cause and effect relationship between the two disorders, however, nor a single pathophysiologic or biochemical mechanism that unites them.[43]

MEDICAL MANAGEMENT OF PANIC DISORDER

To confirm the diagnosis, youngsters presenting with PD-like symptoms should receive a thorough medical and neurologic evaluation in order to exclude nonpsychiatric explanations for the panic attacks (i.e., other medical conditions with similar symptoms). Disorders that may mimic PD include withdrawal from alcohol, sedative-hypnotics and opiates, stimulant abuse (caffeine, cocaine and amphetamines), cardiac arrhythmias, hyperthyroidism, hypoglycemia, pheochromocytoma, and occasionally, complex, partial seizures. Systematic inquiry into the psychiatric status of the child's family members is also indicated because of the highly familial nature of PD.

A multifaceted treatment intervention combining pharmacologic agents and cognitive-behavior therapy can effectively control the symptoms of PD and improve the youngster's quality of life. Medications are usually used initially to control any severe or disabling symptoms.

The tricyclic antidepressants (TCAs) are effective in decreasing the frequency and severity of panic attacks. Imipramine (Tofranil), widely used for such disorders as nocturnal enuresis and childhood depression, has been the drug of choice for youngsters with PD. Tricyclic drug therapy is often associated with adverse

anticholinergic effects (dry mouth, constipation, and sleep disturbance), which may provoke the youngster into discontinuing the medication.[44] The monoamine oxidase inhibitors (MAOIs), another class of antidepressants, are also effective (most commonly phenelzine [Nardil]) and specifically indicated for those patients who have been unresponsive to TCA therapy. Some psychiatrists are reluctant, however, to prescribe this class of drugs because they can interact with tyramine-containing foods (e.g., cheese, aged meats, and red wine) or medications with tyramine-like actions (e.g., amphetamine and ephedrine) to produce life-threatening hypertensive crises.[45] The MAOIs do not cause adverse anticholinergic side-effects. Researchers believe that both the TCAs and MAOIs are efficacious because of their ability to activate the alpha 2 adrenergic autoreceptors in the locus ceruleus, thereby inhibiting release of norepinephrine.[46] These medications must be administered for approximately four weeks before clinical improvement is noted.

Alprazolam (Xanax), an anxiolytic agent of the triazolobenzodiazepine family of medications, is also highly effective in reducing the symptoms of PD at a higher dose than that usually prescribed for anxiety. It is indicated for patients who require medication with a more rapid onset of action. Clinical improvement is usually noted after seven to fourteen days of therapy. The medication works centrally to enhance the action of gammaaminobutyric acid at receptor sites, thus causing a decrease in the firing rate of the locus ceruleus and a subsequent decrease in norepinephrine production.[47,48] Individuals treated with alprazolam frequently complain of daytime sedation, fatigue, memory problems, slurred speech, and dry mouth, but the magnitude of these problems is apparently slight, as very few patients discontinue the medication.[49]

Cognitive-behavior therapy assists patients in modifying inappropriate thought patterns and in developing coping strategies for managing symptoms. A major focus of therapy is educating the patient about the true origin of the physical sensations and psychological experience of PD. During treatment the patient is continually reassured that the chest pain and respiratory difficulties are "real", although not caused by serious organic pathology. Patients also learn simple coping strategies such as positive self-talk, (e.g., "These symptoms are not harmful or dangerous, just unpleasant.").[50]

DENTAL MANAGEMENT OF PANIC DISORDER

Before starting dental therapy, the youngster's treating psychiatrist should be consulted. The child's parents are asked to allow the psychiatrist to release to the dentist the findings of the medical history (including the patient's current psychological status, and current psychotropic medication regime) and the results of the physical examination. If the psychiatrist suspects that the child may have mitral valve prolapse, a cardiology consultation is requested.

The cardiology examination will most likely include a clinical history, cardiac auscultation, and echocardiography. Youngsters diagnosed as having MVP and requiring dental therapy in which a transient bacteremia is likely, may require prophylactic antibiotic coverage. Antibiotics are indicated for that subgroup of patients whose mitral valve leaflets are thickened or redundant or incompetent and permit regurgitation of

Panic attacks can be induced in patients with panic disorder by ingestion of caffeine, inhalation of carbon dioxide, and an infusion of sodium lactate.

blood during systole.[51,52] The antidepressant and anxiolytic medications, while effective in attenuating or preventing panic attacks, do not alter the MVP component of the disorder nor the indications for antibiotic prophylaxis.

Amoxicillin is the drug of choice for preventing endocarditis. The pediatric loading dose is calculated using the child's weight at a ratio of 50 mg/kg. The medication is administered orally one hour before the procedure. As an alternative to calculating the dose—the following schedule may be used: <15 kg (33 lbs), 750 mg; 15-30 kg (33-66 lbs), 1500 mg. Children weighing more than 30kg (66 lbs) are administered the full adult dose of 3000 mg. A follow-up oral dose of amoxicillin, one-half of the initial dose, is administered six hours after the initial dose. For children allergic to amoxicillin/ampicillin/penicillin, the appropriate medication is erythromycin ethylsuccinate or erythromycin stearate calculated at 20 mg/kg. The initial dose of medication is administered orally two hours before the procedure. A follow-up oral dose of medication one-half of the initial dose, is administered six hours later.

The psychiatrist must also be questioned as to the patient's history of alcohol and illicit drug use. Those with a history of alcohol abuse should have liver function tests (blood serum concentrations of hepatic enzymes, bilirubin, albumin, and total proteins), a complete blood count, and a coagulation profile (prothrombin time and partial thromboplastin time) performed.

Profound local anesthesia is mandatory in order to perform dental treatment procedures adequately for these anxious youngsters. Numerous factors must be considered when choosing the appropriate local anesthetic, especially for the young/low-weight child concurrently receiving a TCA. The TCAs potentiate the cardiovascular actions of adrenergic vasoconstrictors. The pressor (elevation of mean arterial and central venous pressures) and arrhythmogenic effects of levonordefrin (Neo-Cobefrin [used in local anesthetic formulations containing mepivacaine]) may be increased to potentially dangerous levels. Thus, it is best to avoid this compound.[53] The interaction of the tricyclics with epinephrine is more modest in magnitude, but a reduction in maximum dosage is prudent in order to ensure patient safety.[54] It is recommended that the dose of 2 percent lidocaine with 1:100 000 epinephrine be limited to one cartridge for every 10 kg or 20 lbs body weight up to a maximum of seven cartridges (in the adult-sized adolescent). Formulations without a vasoconstrictor would seem ideal; the relatively large concentrations of anesthetic agent required for acceptable efficiency (3 percent for mepivacaine, 4 percent for prilocaine), however, make it all too easy for maximum recommended doses to be exceeded in small children.[55,56] They also should be limited to one cartridge for every 10 kg or 20 lbs body weight up to a maximum of seven cartridges.

Anesthetic precautions

Adverse drug interactions between medications used in dentistry and the tricyclics may produce significant morbid reactions. Sedative-hypnotics, anxiety drugs and opiates may have their depressant effects potentiated by TCAs, and severe respiratory depression may ensue. The administration of medications with anticholinergic properties, such as atropine or scopolamine, can cause an increase in intraocular pressure and worsen narrow angle glaucoma.[57]

The monoamine oxidase inhibitors do not potentiate the pressor or cardiac effects of exogenously administered, direct-acting catecholamines. Epinephrine and levonordefrin may be used without special reservation in patients concurrently receiving monoamine oxidase inhibitors.[58] As with TCAs, drugs with central nervous system depressant properties, however, will be potentiated, necessitating extra care when providing conscious sedation for these patients. Meperidine (Demerol) is absolutely contraindicated, because it interacts with MAOIs to produce a life-threatening mixture of central depression and stimulation.[59]

For those patients who request nitrous oxide/oxygen sedation and who are unfearful of the nasal mask, there appear to be no documented contraindications. A standard ambulatory dental anesthesia machine is satisfactory, if the patient is breathing spontaneously. If respiration must be assisted and the machine lacks a carbon dioxide absorber, frequent purging of the rebreathing bag is required in order to avoid hypercarbia and possible induction of a panic attack. Postoperative pain medications containing caffeine (such as Fiorinal) should not be prescribed. Caffeine is a stimulant and, as such, may trigger a panic attack.

Extra effort may be needed to ensure compliance with dental appointments. These patients may be reluctant to come to the dental office alone. They often restrict their normal activities by avoiding public transportation. Episodes of depression may also develop in these patients. During such episodes, there is usually decreased attention to personal and oral hygiene. In

these cases, the responsible psychiatrist should promptly be advised so that appropriate intervention can be instituted.

CONCLUSION

The National Institute of Mental Health launched a campaign in 1991 called the Panic Disorder Prevention and Public Education Program intended to increase public and health care provider knowledge about this disorder.[60] The goal of this paper is to provide dental practitioners with information about the disorder and its impact on dental care.

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THE ROLE OF PREVENTION IN HEALTH REFORM

Important as it is, the need to rein in medical spending must not be allowed to distort the proper role of prevention in the health care system. The primary reason to invest in prevention, as in other medical care, is to promote health — to extend life, improve functioning, and prevent suffering. Preventive interventions should be used whenever they produce more health for the resources invested than alternative services, not only when they save money. Many preventive services do not save money, but some are good values nonetheless, when compared with other uses of the health care dollar. To identify the good values, preventive services should be assessed carefully for effectiveness and cost effectiveness.

Prevention should not, however, be held to a higher standard than other medical services. All medical services should be evaluated for effectiveness and cost effectiveness. To do otherwise is to invest randomly in health rather than to place resources where they do the most good. Leaders of health reform would do well to set two goals for the medical system: the care provided should be proved effective by good science; and among effective services, those that bring the most health for the resources spent should be given the highest priority. If policy makers followed these two principles, there would be a substantial re-thinking of current investments in health in the United States.

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Dental treatment of fearful children using nitrous oxide. Part 4: Anxiety after two years

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The use of nitrous oxide as an aid in the dental treatment of patients who would otherwise avoid going to the dentist is widely accepted. Positive effects upon factors such as fear of pain or loss of control, nausea and inability to relax during dental treatment have been described extensively.[1-6] The limitations and possible drawbacks of its use have also been extensively investigated and treatment procedures have been formulated as a result.[3-9] The main conclusion seems to be that the use of nitrous oxide in dentistry in the 1990s is helping to establish requirements for dosage and evacuation of the used gases, and imposing limits upon the indications for treatment.[8,9] As a result nitrous oxide is considered to be most effective for treating moderately fearful children.[3,4]

The boundaries are less clearly demarcated when the effectiveness of nitrous oxide for treating fearful children is considered. Until recently it was assumed that nitrous oxide was ineffective, if the child's level of anxiety was too high, but recent research indicates that even highly anxious children become less fearful, virtually immediately, when nitrous oxide is used as a support to behavioral management during the dental treatment.[2,10] This level of anxiety reduction was also achieved without nitrous oxide, but only at a much later stage in these children's treatment, and bearing in mind that although the significance of the differences disappeared, treatment with nitrous oxide still continued to yield lower anxiety scores.[10]

One aspect that still needs to be investigated is the permanency of the effect of nitrous oxide: to what extent does the initial reduction in anxiety persist? Is an equally durable effect eventually achieved with behavioral management, and to what extent does this effect persist? Or does nitrous oxide produce only short-term success, with little evidence of effectiveness remaining after a period of time?

In a review article, Corah correctly asserts that "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."[11] Probably, therefore, it is only after determining both the short-term and the long-term effects that a sound conclusion can be drawn as to whether drug-based supporting treatment strategies are necessary, or whether behavior modification techniques are adequate.[12]

A second aspect is the age effect that was previously found for the use of nitrous oxide.[10] It was found that there was a difference in the level of anxiety between relatively young children (from 6-6.5 years old) and older children (8-11 years old). The use of nitrous oxide

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on children is not specifically related to a particular age-group. In general it is used at an age when the child has sufficient verbal and cognitive skills for information to be explained and understood properly.[1,2] In addition, it is easier for the dentist giving treatment if he is able to influence the child's imagination by means of suggestions[2,3]

For the comparison with behavioral management, the age chosen was 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 attention begins to focus more on its environment. Within this age-range, a homogeneous age distribution was sought, to make it possible to investigate whether the reduction in the child's anxiety level found previously is of a permanent nature, and to what extent this is dependent on age. Because of this, the behavior of the children was also observed after the period.

MATERIALS AND METHODS

Selection

Fifty-five highly fearful children who had been referred to our dental fear clinic were selected for this study. The children were between six and eleven years of age and were following normal primary education. For a further description of this study, please refer to articles published earlier.[5,6,10]

In summary, the children were divided randomly into two groups matched by sex and age: one to be treated with behavioral management only (control group), the other with behavioral management and nitrous oxide sedation (experimental group). The children were treated with the objective that the following six-monthly checkup should not result in any curative work. In practice, a period of between 34 and 110 weeks (mean 72 weeks) elapsed before a curative session took place after the treatment phase.[10] The mean age of the children at that time was 9.2 years. Thirty-five children took part in this long-term follow-up study.

The behavior of the treated children was scored on the basis of video recordings. The tapes were evaluated independently by two trained observers (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 to conduct the evaluation.[13] Because the children in the present study belonged to a different (older) age-group, a number of modifications had to be made, relating primarily to these children's more verbal expressions of fear and their generally greater degree of self-control in frightening situations (Figure 1). The child's level of fear during a treatment session was scored on a six-point scale varying from 0 (relaxed) to 5 (no further contact possible); this was the overall score (OS). This score indicates the child's average behavior during a treatment session. A score was also given for the moment at which the child behaved the most anxiously; this was the peak score (PS). This was done to prevent the score for a moment of fear about a single part of the treatment (e.g. anaesthetization) from dom-

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

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* to accept 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 *Anxiety* interferes with ability to asses situation. General crying not related to treatment. Prominent body movements, needing occasional physical restraint. Child can be reached through verbal communication, and eventually with reluctance and great effort begins to work to cope. Protest disrupts procedure.

5 *Out of contact* with the reality of the threat. Hard, loud crying. Screaming, swearing. Unable to listen to verbal communication. Regardless of age, reverts to primitive flight responses. Actively involved in escape behavior. Physical restraint required.

inating the score for a session as a whole. The method used to process the overall score (OS) and the peak score (PS) are described elsewhere.[10]

Six dependent variables are included in the main analysis. In all cases these are the mean values for the relevant curative sessions for both study groups:

- ☐ OS1: Overall score for the first session of the treatment phase.
- ☐ PS1: Peak score for the first session of the treatment phase.
- ☐ OSL: Overall score for the last session of the treatment phase.
- ☐ OSN: Overall score for the first session after the treatment phase.
- ☐ PSL: Peak score for the last session of the treatment phase.
- ☐ PSN: Peak score for the first session after the treatment phase.

Statistical Analyses were performed by using SPSS/PC+V4.0.[14]

RESULTS

The overall and peak scores for the first curative session after the treatment phase are given in Tables 1 and 2.

The tables show clearly how closely the new overall scores within each condition correspond with the scores for the last curative session of the treatment phase. The peak score for the experimental condition has only risen slightly, while the score for the control condition shows a significant increase ($p = 0.006$, significant if $p \leq 0.05$). If the two conditions are compared, it can be seen that there is still a significant difference between the two conditions. The effects are the same for both experimental conditions.

The present study investigated whether an age effect is apparent in this phase of the treatment. The correlation between age and the overall and peak scores, however, was found to be very low (.10 and .04 respectively). This also applied to the correlation between the anxiety scores and the number of weeks that elapsed between the new treatment and the last curative treatment (.00 and .02 respectively). Correlation calculations further indicated that there was a relatively close relationship between the OSN and OS1 (.49) and a clearer relationship between the OSN and OSL (.65). Relatively close correlations were found for the peak scores (.48 and .49 respectively).

Experimental analysis

For five patients, the new treatment was carried out after they had been switched from the experimental condition to the control condition. The mean scores for these treatments are given in Table 3. Although no calculations can be made because of the limited numbers of children, comparison of Table 3 with Tables 1 and 2 reveals that the new peak scores in particular clearly lie closer to the scores for the control condition than those for the experimental condition.

DISCUSSION

The pattern of the anxiety scores for the behavioral management group indicates that even after a long interval of time, a fearful patient is still afraid during a curative session. This can be seen most clearly from the peak scores: these scores are significantly higher

Table 1 ☐ Differences between overall scores for the control condition (behavioral management), and the experimental condition (treatment with N20) including p- and t-values.

	B.M. (n = 21) X	s.d.	N20 (n = 15) X	s.d.	p)*	t
OS1	2.57	1.29	1.53	1.13	.008	3.57
OSL	1.71	1.01	1.40	0.74	.014)*	1.08
OSN	1.95	1.02	1.33	0.82	.026	2.02

)* t-test; sign. if $p \leq 0.05$
)** significance disappears after correction for age

Table 2 ☐ Differences between peak scores for the control condition (behavioral management), and the experimental condition (treatment with N20) including p- and t-values.

	B.M. (n = 21) X	s.d.	N20 (n = 15) X	s.d.	p)*	t
PS1	3.48	1.21	2.27	1.28	.004	2.86
PSL	2.33	1.07	1.80	0.56	.003)**	1.95
PSN	3.00	1.14	2.20	1.42	.042	1.80

)* t-test; sign. if $p \leq 0.05$
)** significance disappears after correction for age

Table 3 ☐ Average fear scores after switching from experimental condition (N20) to control condition (B.M.).

	X (n=5)	s.d.
OS1	2.00	1.23
PS1	2.60	1.14
OSL	1.60	1.67
PSL	2.20	1.48
OSN	1.60	1.67
PSN	3.00	1.59

than those for the previous session. This fact is also known from other studies of the treatment of fearful patients: a reduction in the anxiety scores of fearful patients during regular treatment was described earlier, in combination with an increase as the time intervals between the treatments increased.[15]

These findings, combined with the fact that the anxiety scores for the nitrous oxide group are significantly lower in all cases, indicate that a clear level of fear of the dentist persists in children who were originally highly fearful, and that nitrous oxide is also a good aid for helping patients to cope with this in the longer term. Highly anxious children's fear level can be reduced in the short-term, but in the long-term their fear clearly reappears to a certain extent.[10]

One possible disadvantage is the fact that in the long-term, the child can thus remain more dependent on an aid such as nitrous oxide in his/her attempts to cope with the dental situation. As described earlier, nitrous oxide thus produces a dependency that would possibly have developed in any case: dependency on the person of the dentist or on the specific ritual of a treatment.[10]

As described earlier, there was no relationship between the time between two treatments and the level of anxiety.[10] The high anxiety scores persisted in the behavioral management group after many weeks indicate that fear of the dentist must be something other than a time-related factor. Particularly after a long period of time, some portion of the fearful behavior returns: the learning effect is evidently subject to extinction.

The clear correlation between the last anxiety scores for the treatment phase and the score for the first subsequent curative session gives the last session clear predictive value for anticipating the further development of the patient's anxiety during treatment, and it is thus of importance to the anxiety-reducing therapy to be given subsequently.

The absence of any correlation between the age and the fear scores obtained can possibly be explained by the higher mean age of the children (1.5 years older on average). Clearly the children behave more similarly to one another; the difference in expression between the younger and older children that was found earlier has disappeared, because there are now only older children.

It was reported earlier that in the last session of the treatment phase, there was no longer any significant difference between the anxiety scores for treatment with or without nitrous oxide.[10] In particular this difference disappeared after correcting for an age difference between the groups. Because the present study was a follow-up study of an existing, consistent group of children, and the correlation between age and fear scores had disappeared so that no further correction was needed, the scores were compared with the first fear scores before these scores were corrected for age.

The experimental condition, which was switched over from nitrous oxide to behavioral management is promising. Based upon these extremely preliminary figures, serious consideration must be given to the possibility that the temporary use of nitrous oxide is insufficient to reduce children's fear permanently. Further research will thus need to be conducted on the extent to which children continue to need nitrous oxide after initially being treated with nitrous oxide. Once a child has learned to relax well with nitrous oxide, it might also be capable of being treated without this aid in the long-term. It will also be necessary to study the extent to which a high peak score during an otherwise relaxed treatment can influence the child's fear of the dentist in the long-term.

CONCLUSIONS

- ☐ Fearful behavior in children is still clearly present 1.5 years after the first treatment phase.
- ☐ Nitrous oxide is also a useful long-term aid in the treatment of children who are initially highly fearful. Treatment with nitrous oxide yields significantly lower fear scores.
- ☐ The level of fear during the last session of a course of treatment has clear predictive value for the following curative session, even if this takes place two years later.
- ☐ Differences in expressing fearful behavior between younger (6-6.5 years) and older (8-8.5 years) children disappear while the children are getting older.

SUMMARY

A group of highly fearful children were treated using behavioral management, or nitrous oxide and behavioral management. This article describes the childrens' fears during the first curative treatment one to two years after the first treatment phase, and to study whether the reduction in the child's anxiety level found previously is of a permanent nature.

The results of this study indicate that fear reduction using behavioral management is not permanent: the first curative treatment after seventy-two weeks results

in significantly higher fear scores (PS). When combining the behavioral management with nitrous oxide, the fear scores show the same low level as at the previous treatment.

The fear score during the last session of a course of treatment is clearly related to the score of the following curative session, even if it takes place two years later.

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LASER INDUCED TEMPERATURE CHANGES

The previous opinion, based on earlier results of Adrian et al. [1971], that lasers cannot be used to remove carious tissue in restorative treatment because the energy required for carious tissue ablation would cause extensive coagulative necrosis of pulp tissue should be reconsidered. Years later Adrian [1977] found that no thermal injury of pulp tissue is encountered in caries lesion ablation using controlled infrared laser energy. Other in vitro studies using the described methods confirm this view: Neiburger and Miserendino [1988] found maximum increases of 3.5°C with laser energies ranging from 3 to 24 W. This increase was below the critical temperature of 5.6°C at which initial pulpal reaction occurs [Shoji et al, 1985; Meyers and Meyers, 1985]. Our results showed larger temperature increases inside the pulp chamber with the lower laser energy, but with 10–20 times longer exposures the values found by Neiburger and Miserendino [1988]. We also treated enamel surfaces with higher, and dentin at the cavity bottom of class I preparations with lower laser energy. The findings of charred regions of dentin might indicate temperatures sufficiently high to carbonize the organic matter in dentin.

Concluding from temperature changes, powers of 1 W for an exposure time of up to 1 s would probably not cause irreversible pulp tissue changes. Under in vivo conditions the pulp-dentin complex would be subject to the greater thermal conductivity.

Relatively high energy of CO_2 irradiation produces phenomena of partial fusing and recrystallization of enamel. Previous investigators [Kantanola et al, 1973; Kuroda and Flower, 1984] reported occurrence of α-TCP and TetCP as well as recrystallization and crystal growth of hydroxyapatite. In our study X-ray diffraction analysis of melted enamel revealed the presence of α-TCP, but there was no proof of TetCP formation.

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NURSING CARIES

Nursing caries and lactose intolerance

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Lactose is the major source of carbohydrate calories in breast-fed and most formula-fed infants.[1] Lactose also contributes to absorption of calcium, magnesium and manganese in humans.[1] Lactose, the principal carbohydrate in mammalian milk, is a disaccharide, which must be hydrolyzed to the monosaccharides, glucose and galactose, to be absorbed in the intestinal tract. The enzyme lactase, which is localized in the intestinal brush border, is responsible for the hydrolysis of lactose.

Lactose intolerance is a term applied to the gastrointestinal symptoms caused by malabsorption of ingested lactose-containing products.[2-4] A number of factors may affect lactose absorption by influencing the activity of the enzyme lactase.[5] Among these factors are age, ethnicity, and integrity of the intestinal mucosa.[1] Lactose intolerance can lead to milk intolerance. The other cause of milk intolerance is cow-milk protein intolerance, sometimes called cow-milk allergy. Lactase deficiency is a far more common cause of intolerance to milk than cow-milk protein intolerance, although the sensitization caused by the latter may predispose to lactase deficiency and, ultimately, to lactose intolerance.[2,6]

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The etiology of lactose intolerance is multiple. Its cause can be congenital or acquired.[2,5,7,8] Congenital alactasia is rare except in Finland. There is evidence for the autosomal recessive mode of inheritance of the disease.[8] Typical symptoms include diarrhea, which starts soon after beginning milk feeding, good appetite and absence of vomiting.

Primary lactase deficiency occurs in individuals who have adequate lactase activity during infancy, but declining levels beginning sometime after the age of weaning. The lactase decline is inherited and the racial incidence varies from 5 percent to 97 percent in various populations.[2,5,7] For example, one study of Israeli children showed that 61.8 percent were malabsorbers, 60.3 percent of whom were lactose-intolerant with symptoms evidenced during or following tests, whereas 39.7 percent were symptom-free. In the youngest age-group (4 months to 3 years), no lactose malabsorption was detected.[4] In a similar study in Jordanian infants and young children, lactose intolerance was present in 10-36 percent of the one- to twelve-month-old children, and in 11-88 percent of the one- to twelve-year-old children.[9]

Secondary lactase deficiency, potentially reversible, may result from two conditions:

- ☐ Injury to the small intestinal mucosa resulting in diminished lactase activity; or
- ☐ Surgical removal of large area of the bowel.

The most common cause of secondary lactase deficiency is infectious enteritis, although the condition

also may be caused by cow-milk-protein intolerance, celiac disease, intestinal irradiation, antimetabolite therapy, malnutrition, intestinal resection ("short bowel"), immunodeficiency, giardiasis, inflammatory bowel disease, and antibiotic therapy (i.e. neomycin).[7,10,11]

Symptoms and signs of lactose intolerance include abdominal bloating, cramping, diarrheal stools of high acidic content, nausea, vomiting, audible borborygmi, colicky abdominal pain, and flatulence. Recurrent abdominal pain in children is a common condition, which may be associated with lactose malabsorption.[2,7] A recent study of eighty children with recurrent abdominal pain utilizing the lactose hydrogen breath test (LHBT), showed lactose malabsorption in 40 percent of children; 70 percent of these had clinical symptoms of intolerance.[2] LHBT appears to be the most sensitive functional test to confirm a diagnosis of lactase deficiency. The probability of a false normal LHBT is as low as 1:77 and the LHBT is superior to conventional blood glucose determination in diagnosing lactose intolerance.[12]

Lactose malabsorption is prevalent in black children. Paige *et al* studied lactose malabsorption in 409 black children ages thirteen months to twelve years, drawn from four well-child clinic sites and a private pediatrician's office in Baltimore, Maryland.[5] The prevalence of lactose malabsorption among these children demonstrated a progressive increase in lactose malabsorption with age, both for high and low socioeconomic status. Twenty-seven percent of children, ages one to two years; 33 percent of children, ages five to six years; and 74 percent of children, ages eleven to twelve years were malabsorbers.

Another disease, nursing caries, represents a challenge to the same community. Clinical observations by instructors in pediatric dentistry at the University of Maryland at Baltimore, Dental School, suggest that nursing caries occurs in high numbers.

The etiology of nursing caries is related to inappropriate nursing bottle habits. The use of sweetened pacifiers, vitamin syrups, fruit juices, and carbonated beverages as ingredients in the bottles of children and excessive breast feeding are etiological factors. The duration of the habit, whether with the bottle, breast or sweetened pacifier, beyond the normal weaning period is an important contributing factor. A recent study on nursing caries found a strong and significant relationship between the severity of nursing caries and the time spent in deleterious feeding practices.[13] Children with nursing caries reportedly practiced the nursing habit 8.3 hrs/day compared to only 2.2 hrs/day for children without nursing caries.

Fermentable dietary carbohydrates are clearly associated with the formation of dental caries. Sucrose is considered to be the major cariogenic food in the human diet. For children with nursing caries, the nursing bottle is adulterated by the addition of table sugar or other cariogenic sweetening agents.[14] It is possible that children whose parents perceive them to be lactose intolerant substitute fruit juices and carbonated beverages for milk or milk products. Although animal studies show that lactose in milk can enhance the oral implantation of cariogenic bacteria in animals and produce caries when fed to animals, the issue of bovine or human milk being linked to nursing caries is complex.[15] In addition to its potentially cariogenic lactose content, milk contains ingredients that may protect against caries, such as calcium and phosphorous.[16,17] Lactose intolerant children may be at a high risk of developing carious lesions because they do not benefit from these protective mechanisms. Under normal dietary conditions, milk has low cariogenicity, but in cases of nursing caries, usual dietary conditions do not prevail.

The influence of cultural and ethnic factors on infant feeding habits makes comparison of studies of different ethnic types difficult. Examinations for nursing caries are less rigorous than those conducted on older children, because infants are difficult to examine. Also, different criteria have been employed to diagnose nursing caries. These include: comparison of the pattern of decay with photographs of nursing caries; minimum of two maxillary incisors with labial or lingual lesions; clinical appearance and history of nursing habits; anterior smooth surface caries activity, cavitation of at least three maxillary incisors; and labiolingual lesions on maxillary incisors.[14]

The prevalence of nursing caries varies, depending on the country: Canada, 3.2 percent; Australia, 5.4 percent; South Africa urban blacks, 3.1 percent and rural blacks, 13.7 percent. The prevalence of nursing caries in England declined from 8 percent to 3 percent sixteen years later.[18] This decline was attributed to a reduction in the use of sweetened pacifiers.

In the United States, the prevalence of the disease varies from 1 percent to 53.1 percent depending on the ethnic group studied. Native American children appear to be at a substantially higher risk than other population groups. Reports of nursing caries in Native American children in Head Start Centers show that 72 percent of the Navajo sample studied and 55 percent

of the Cherokee sample exhibited nursing caries. Of these children, 87 percent were categorized as being in the most severe category of nursing caries.[19,20]

Several significant differences in characteristics and backgrounds were found between children with nursing caries and caries-free children. Almost all children (95 percent) with nursing caries were put to sleep with the bottle. Parents of children with nursing caries were less likely to have attended college, and were more likely to be pessimistic about their own dentition, be obese, be reluctant to say "no" to the child, and be unaware of the cariogenic potential of sleeping with milk or other sweet liquid.[21] Another report showed that 97 percent of the children were bottle-fed until 23.4 months of age, and had a history of use of the bedtime bottle or breast beyond the normal weaning time.[22] Frequency of nursing caries was related to parental overindulgence or lack of control. Children with this syndrome were more likely to be living in a single parent household, and have a higher incidence of sleep difficulties and strong temper. Parents also received less professional advice regarding weaning.

Treatment needs for black children in the United States in the primary posterior dentition was reported to be 40 percent restorations, 8 percent extractions and 7 percent crowns.[23] The relation to nursing caries, however, was not reported.

If the reason for replacing milk with other more cariogenic liquids is related to physiologic intolerances, such as lactose intolerance, then identification and education of those groups may help minimize the prevalence of nursing caries. Identification of predisposing factors for these patients is important in counseling parents and in developing preventive strategies. For example, the population could be encouraged either to use lactose-reduced milk or have the child tested to determine whether she is truly a lactose malabsorber. Multiple strategies could be devised, short of substituting high sucrose, fructose, or sorbitol drinks for milk.

Various forms of milk products are better tolerated by lactose intolerant patients than are others. Many of these children can tolerate small amounts of milk products without showing clinical signs of lactose intolerance. There appears, however, to be a tendency for these patients to eliminate milk from their diets. [1] Although the lactose hydrogen breath test is the best method of diagnosing lactose intolerance, a questionnaire concerning diet and symptoms consistent with lactose intolerance may indicate whether it is worthwhile to proceed with expensive laboratory testing in a larger population.

The purpose of this investigation is to compare the prevalence of symptoms consistent with lactose intolerance in black children with nursing caries to that of caries-free black children. Our research hypothesis is that parents of children with nursing caries are more likely to perceive their children to have problems tolerating milk as compared with parents of caries-free children. An additional purpose of this study is to determine whether there are differences in feeding habits and types of fluids given to children with nursing caries as compared to caries-free children.

MATERIALS AND METHODS

Population

The study population included sixty black children from Baltimore, Maryland, ages eighteen to fifty-four months, male and female, who presented to the University of Maryland Dental School for a screening appointment, or who were patients of the Western Health Center.

The first consecutive thirty black children, ages eighteen to fifty-four months who were caries-free upon screening were included in one group. A second group was composed of the first consecutive thirty black children, ages eighteen to fifty-four months diagnosed with nursing caries during the screening examination.

Experimental design

Following approval of the research protocol by the Human Volunteers Research Committee, parental consent to participate in the study was obtained before admitting the child to the study. A questionnaire was given to the mother or father of each child. The questionnaire included questions to determine whether symptoms of lactose intolerance were exhibited by the child or the parents. It also included questions about feeding patterns.

At the screening appointment, the presence of nursing caries was determined. The examination was conducted by the same examiner in all cases, using a mouth mirror and a sharp #23 explorer to determine the dmfs. The teeth were dried with compressed air before the examination.

The diagnostic criteria as used in this study were based on the dental caries pattern of three carious maxillary incisors and not on nursing history.[14] Radiographs were not a criterion for inclusion, since they are not routinely obtained at the screening appointment, the first dental visit for most of the pediatric patients.

In patients with a maxillary incisor missing, it was assumed the tooth was decayed, if the possibility of an earlier traumatic injury was ruled out by questioning the parents of the child.

Children were categorized as caries-free by the absence of decay and/or restorations. Children with missing teeth were not included in this group.

Data analysis

Student t-test was used to determine any significant differences in mean scores for lactose intolerance symptoms between both groups, and to determine any significant difference in the mean age at which bottle feeding was discontinued between both groups. Chi-square analysis was employed to test any significant differences between the rest of the variables studied. In all cases, a level of $p \leq 0.05$ was accepted as significant.

RESULTS

Bottle feeding

The results show that the vast majority of the subjects in our study were fed, using the baby bottle. In the nursing caries group, twenty-seven of thirty nursing caries children and twenty-eight of thirty caries-free children were bottle fed. The difference between groups was not significant. Significantly more children with nursing caries, however, used the bottle at bed time than caries-free children (Figure 1). Only two of twenty-nine caries-free children were put to bed with the bottle, whereas twelve of thirty children in the nursing caries group were bottle fed at bed time. The difference was significant at the .01 level ($X = 7.19$; $df = 1$; $p = 0.007$).

At the time of our study, nine of thirty children in the nursing caries group and seven of thirty in the caries-free group were still drinking from the bottle. The difference was not significant. The mean age at which the use of the bottle was discontinued was 26.5 +/− 13.44 months for the nursing caries group, and 18.78 +/− 12.30 months for the caries-free group. Although the difference was not statistically significant at the .05 level ($t = 1.964$; $df = 41$; $p = 0.056$), there was a strong tendency to continue the use of the baby bottle for a longer period of time for the nursing caries group (Figure 2).

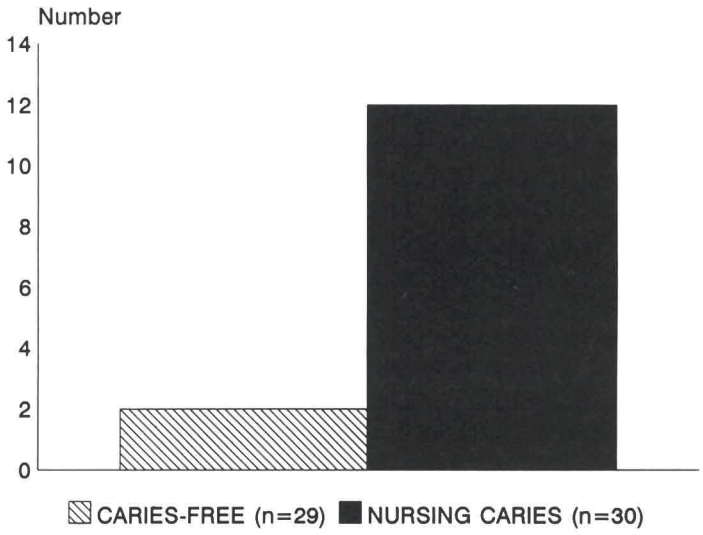

Figure 1. Number of caries-free and nursing caries subjects fed with the baby bottle at night.

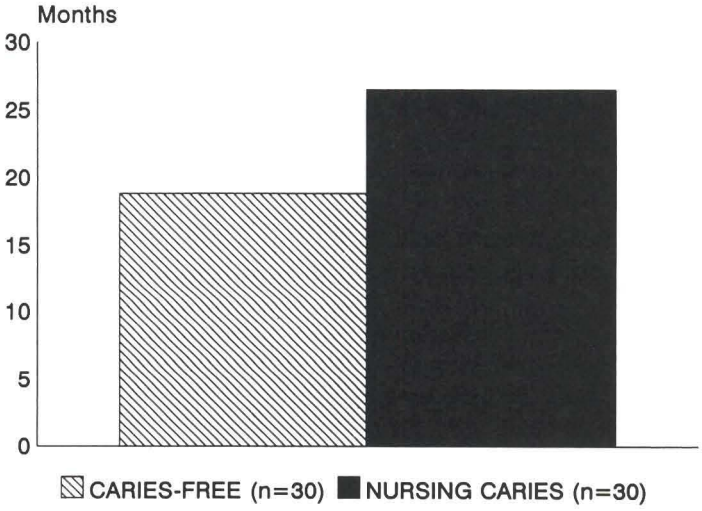

Figure 2. Mean age at which baby bottle-feeding was discontinued.

Liquids in the bottle

Table 1 illustrates the answers obtained, when parents were asked about the liquids in the bottle. No significant differences were found between the groups for any of the liquids tested. Not all the parents answered every question.

Table 1 ☐ Liquids placed in the baby bottle.

Liquid	Nursing Caries		Caries free	
	No. positive answers	No. subjects	No. positive answers	No. subjects
Wholemilk	22	28	23	28
2% Milk	1	26	5	24
Skimmed milk	2	25	2	24
Evaporated milk	3	27	2	24
Condensed milk	1	26	0	24
Hi-C, Fruit drinks	21	28	19	27
Soda/Pop	15	27	15	25
Sweetened tea	9	25	7	25
Juices	28	30	25	27
Other sweetened drinks	9	24	9	24
Cow milk-based formula	7	24	3	21
Non-cow Milk-based Formula	10	24	5	24

Table 2 ☐ Liquids children drinking at time of study.

Liquid	Nursing caries		Caries free	
	No. positive answers	No. subjects	No. positive answers	No. subjects
Whole milk	20	30	26	29
2% Milk	1	24	2	24
Skimmed milk	0	24	2	24
Condensed milk	10	23	8	24
Hi-C, Fruit drinks	23	27	18	26
Soda/Pop	18	25	17	26
Sweetened tea	10	22	7	23
Sweetened coffee	0	21	1	21
Juices	26	29	25	26
Other sweetened drinks	5	22	7	22

Parents were asked to choose from the same list the two liquids that were placed in the baby bottle most often (Figure 3). Children in the caries-free group were given milk significantly more frequently than the nursing caries group ($X = 5.27$; $df = 1$; $p = 0.02$). In the nursing caries group, sixteen of thirty children had milk among the two most frequently consumed liquids, whereas twenty-three of twenty-seven children were in this situation in the caries-free group.

No significant differences were observed between groups in the liquids children were receiving at the time of the study (Table 2). Children with nursing caries had a strong tendency, however, to consume whole milk less frequently than children in the caries-free group ($X = 3.29$; $df = 1$; $p = 0.069$). Twenty of thirty children in the nursing caries group and twenty-six of twenty-nine in the caries-free group were receiving whole milk at the time of our study (Figure 4). Skimmed milk and 2 percent milk were taken infrequently by both groups.

Sleeping disturbances

Ten of twenty and seven of twenty-two children in the nursing caries and caries-free groups, respectively, were reported to have problems sleeping during the night. The difference was not significant. Most parents did not associate problems children had sleeping with milk/milk products consumption. Only two parents in the nursing caries group and three parents in the caries-free group thought that the sleep disturbances were caused by milk. The difference between groups was not significant.

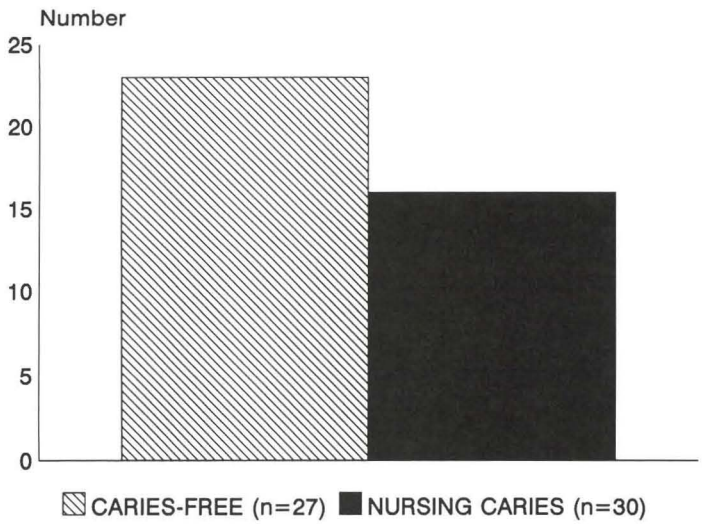

Figure 3. Number of children receiving milk as one of two most frequently consumed liquids from the bottle.

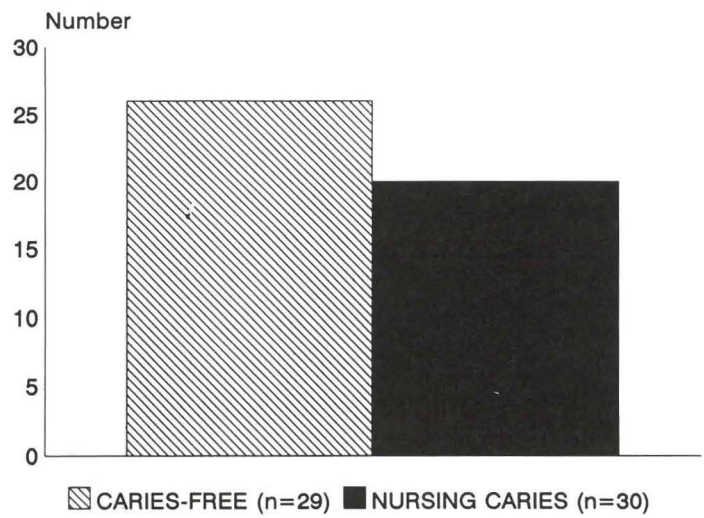

Figure 4. Number of children currently drinking milk.

Lactose intolerance

Parents were asked to report whether milk or milk products caused any of the following symptoms: diarrhea, gas, bloating, cramps, and colic. A final "Symptoms of lactose intolerance score" was calculated for each subject (Figure 5). Mean scores were 1.53 p/− 2.35 for the nursing caries group and 0.66 +/− 1.29 for the caries-free group. Although the difference between groups was not significant, ($t = 1.76$; $df = 41$; $p = 0.083$), there was a tendency for children with nursing caries to present with a higher score for lactose intolerance symptoms.

According to parental reports the vast majority of children in both groups ingested milk products. Cheese and ice cream were eaten by all children in the caries-free group. Two of twenty-eight children with nursing caries, however, did not eat cheese and two of thirty did not eat ice cream. The differences between groups are not significant.

According to parental information, one child of twenty-nine with nursing caries and none of thirty in the caries-free group were previously diagnosed as lactose intolerant by a physician. The criteria for the diagnosis, however, are unknown. Three of twenty-nine children in the nursing caries group were diagnosed with milk allergy, whereas none of thirty children in the caries-free group was known to have that condition. These differences were not significant. The only child to be diagnosed with lactose intolerance was also diagnosed as having milk allergy.

Two of thirty parents in the nursing caries group and four of thirty in the caries-free group admitted having problems digesting milk. The difference was not significant. Only one parent in the nursing caries group and none in the caries-free group was diagnosed with lactose intolerance. The difference was not significant. No parent in either group admitted having milk allergy.

Parents were finally asked about the influence their own problems with milk consumption had on their child's feeding practices. The vast majority of parents indicated that there was no relationship between the issues. The difference between groups was not significant.

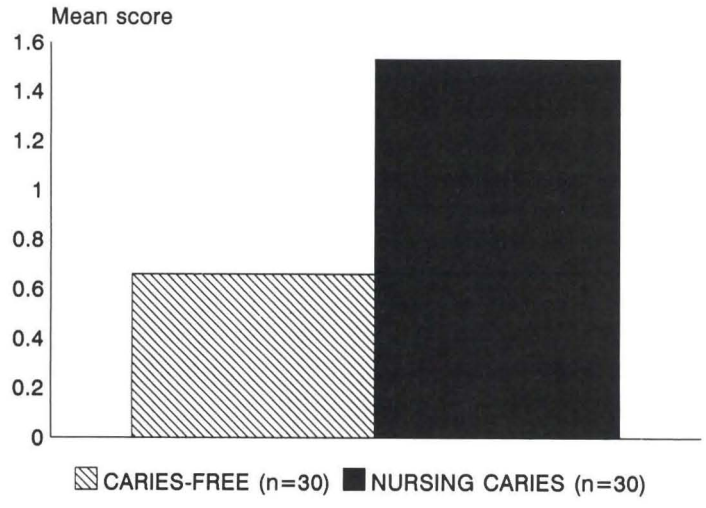

Figure 5. Mean score of symptom of lactose intolerance.

DISCUSSION

The results show that most children in both the nursing caries and the caries-free groups were fed, using the baby bottle. No significant difference was found, when the duration of the feeding pattern was examined, although there was a strong tendency for the children with nursing caries to use the baby bottle for a significantly longer time. The children who developed nursing caries were kept on the bottle until the mean age of 26.5 months, whereas caries-free children had the bottle until the mean age of 18.78 months. There was a wide variation in both groups as to when the bottle feeding was stopped. The reasons for continuing the bottle feeding for so long in both groups should be investigated.

Fewer caries-free children had the bottle at bed time than children with nursing caries. These findings are in general agreement with previous reports for this age-group.[21,24]

Not all patients who fit our criteria of nursing caries had a history of using the baby bottle. The etiology may be related to breast feeding. No questions were asked, however, to confirm this supposition.

More children in both groups received non-cow milk-based formula than cow milk-based formula (Table 1). This may indicate a perceived intolerance to cow milk or lactose. More nursing caries children received cow milk-based formula, however, than the caries-free children did, although the difference was not significant. Although the study is retrospective, and, therefore, parents' memories may be faulty, it appears that a large number of children in both groups, particularly in the caries-free, group did not receive formula.

Generally, 2 percent, skimmed, or evaporated milk are not recommended for infants or toddlers because of their low caloric value.[25] A few children in each group, however, received these liquids. Numerous children in both groups received juices and other sweetened drinks in their bottles. Although there were no significant differences seen between the groups, the

lack of nutritional value for soda, fruit drinks, sweetened teas and other drinks is a major concern. Many children were still drinking these nutritionally deficient fluids at the time of the study (Table 2).

Although parental education was indicated by the data, the study by Dilley *et al* indicates that a large percentage of informed parents continue the feeding habits for their children.[22] Additional research is necessary to determine the reason for noncompliance with instructions, especially when it means pain to the child and financial cost to the parent.

A significant difference was found when parents were asked to select the two most commonly used liquids. Whole milk was given to the caries-free children more frequently than children with nursing caries. This finding indicated that, although children in the nursing caries group may be drinking milk, the frequency of the intake of that product is lower than for caries-free children.

The low cariogenic potential of milk was suggested by previous studies.[14] The acidic byproducts of the carbohydrate lactose, present in human and bovine milk can demineralize tooth enamel.[17] Some of the milk ingredients, such as calcium, proteins, and phosphorous, however, were attributed a protective role against decay.[16,17] In fact the addition of milk to diet decreased caries production in laboratory animals.[16] Proteins like casein, which are present in milk, were thought to form a protective organic coating on the tooth surface. One study reported that milk has a low cariogenic potential and that caries production in laboratory animals decreased by the addition of milk to the diet.[16] Our study supports the assumption that milk may play a protective role against caries production.

Skimmed milk and 2 percent milk were ingested by few subjects, whereas juices were consumed by the majority of the subjects in both groups. The ingestion of fruit juices can produce an acid attack in which the decrease in pH is comparable to that caused by a 25 percent sucrose rinse.[14] Children fed with fruit juices in the baby bottle may be exposed to a much higher and continued cariogenic environment when compared with children receiving milk in the bottle. The sole presence of fruit juices alone does not explain, however, the occurrence of nursing caries. In fact most caries-free children in our study also consumed juices. We measured symptoms of lactose intolerance by obtaining a final "Symptoms of Lactose Intolerance Score" which would indicate the relative perceived duration and severity of the condition among different subjects. The results obtained indicate that, although children with nursing caries were drinking milk less often than caries-free children, the reason could not be definitely attributed to lactose intolerance. A lactose hydrogen breath test (LHBT) is indicated for a definitive diagnosis of lactose malabsorption. In our study we only measured reported symptoms of that condition among black children. Although there is a strong tendency for parents of children with nursing caries to report more severe and persistent symptoms of lactose intolerance, the difference with caries-free children is not significant.

Children with lactose intolerance, however, tolerate various milk products differently. Children with lactose intolerance can tolerate whole milk better than skim milk and chocolate milk better than whole milk. Aged cheese and yogurt may be tolerated better than whole milk. Some children can tolerate milk with meals better than milk alone.[1]

These results also may be explained by the age of the subjects studied. Paige *et al* determined that the prevalence of lactose malabsorption among black children increases with age.[5] Twenty-seven percent of children in the one-to-two year range are malabsorbers, compared to 74 percent at the eleven- to twelve-year range. The lower incidence of the condition among infants and young children may explain our findings. The inability of the subjects to communicate their symptoms makes it difficult for parents to determine accurately the reasons for crying or other types of disruptive behavior.

Diagnosis of lactose intolerance by clinical symptoms alone can be difficult. Although previous studies report that 70 percent of children with lactose malabsorption had clinical symptoms or signs, a high percentage of children with symptoms did not have lactose intolerance.[2] In addition, intolerance to other forms of carbohydrates may also have similar symptoms.[26] There is agreement in the fact that the LHBT is the best way to confirm a diagnosis of lactose malabsorption. To be able to determine the exact relationship between lactose intolerance and nursing caries our subjects would have to be tested using the LHBT to determine the exact prevalence of lactose intolerance.

The difference in dietary habits observed between both groups of children does not appear to be related to the presence of lactose intolerance among parents. Children were not receiving less milk, therefore, because their parents had problems digesting milk and assumed their children could not digest milk. Based

on the findings of this study, we can not explain definitively why children with nursing caries are receiving less milk than caries-free children.

As mentioned before, a protective effect against caries is attributed to milk.[16,17] Our findings seem to support the beneficial role of milk, or at least of its lower cariogenic potential, when compared to other sweetened liquids. Further research is needed to clarify this issue. Additional studies should include the use of the

LHBT for diagnosis of lactose intolerance, since there was a strong tendency toward significantly higher reported clinical symptoms consistent with lactose intolerance among the nursing caries group as compared with the caries-free group. Additional studies should also include older black children who have a high incidence of lactose intolerance.

CONCLUSIONS

Black children with nursing caries were put to bed with the bottle more often than black caries-free children of the same age. They also had a tendency to be kept on the bottle for longer periods of time than caries-free children.

Children with nursing caries received milk in the baby bottle significantly less often than their caries-free counterparts, although there was only a tendency for nursing caries children to have higher lactose intolerance scores than caries-free children. No differences were found between groups, concerning a perceived relationship between symptoms consistent with lactose intolerance and milk products. Parents in both groups did not regard their own problems digesting milk as an influence on what was given to their children.

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THUMB-SUCKING

Thumb-sucking: Literature review

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The concern about thumb-sucking and finger-sucking habits is evident by the number of articles that have appeared in scientific journals in the past fifty years. Interest in this topic has been shared by psychiatrists, psychologists, pediatricians, pediatric dentists, orthodontists, speech therapists, and plastic surgeons. Even the lay public has contributed to this much-debated topic. Despite the extensive research that has been conducted, however, considerable controversy' still exists regarding sucking habits.

Thumb-sucking habits are often considered within a broad category of habits that includes finger-sucking. Hence, thumb-sucking and finger-sucking habits are more generally termed "digit-sucking" habits. A broader category of sucking habits includes any form of nonnutritive sucking (NNS) that involves pacifiers, hair, etc. These terms are used interchangeably in this article but they imply sucking habits related to the thumb and fingers.

Because of the frequent dentofacial manifestations of a prolonged NNS habit, the combined psychologic and dentofacial consequences of the extended habit often become the concern of dentists or dental specialists. Accordingly, much of our knowledge about the treatment of thumb-sucking has been provided by orthodontists, most notably by Graber, Larsson and colleagues, and Haryett *et al*[1-15] The confusion about thumb-sucking arises from the complex nature of the condition and the difficultly in conducting quantitative scientific experimentation. Much of the research is based on small samples and no controls. Another difficulty stems from the cross-disciplinary nature of the information. Investigators in each specialty seem partial to research done in their specific area of interest.

The purpose of our report is to review the literature relative to the causes, risks, prevalence, and contributing factors of NNS. This review summarizes important details from numerous studies that cross several fields of research in an effort to support and to challenge contemporary beliefs about the many aspects of digit-sucking habits.

CAUSE

The two prominent theories of behavior that address the problem of NNS are the psychoanalytic theory of psychosexual development as proposed by Freud and the learning theory. Despite differences, the psychoanalytical and learning theories are similar in that both describe factors responsible for the origin and maintenance of the habit.

Origin of the Habit

Both theories support the idea that some developmentally normal condition promotes the origin of NNS.

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The psychoanalytic theory holds that this original response arises from an inherent psychosexual drive. Freud differentiated NNS from the need for nourishment, suggesting that NNS is a pleasurable erotic stimulation of the lips and mouth. He concluded, as quoted by Davidson *et al* that "psychoanalytic investigation justifies us in claiming thumb-sucking as a sexual activity."[16] One of the concepts of thumb-sucking that is brought out by the psychoanalytic theory is that humans possess a biologic sucking drive. This concept is supported by the observation of intrauterine sucking and by the neonatal reflex of rooting and placing, as described by Benjamin.[17] In the rooting reflex, if a well-defined area around the mouth is touched by an object, an infant turns the head toward the object and opens the mouth. The placing reflex is the sucking activity that occurs with the object making contact with the infant's mouth.

The learning theory advocates that NNS stems from an adaptive response.[18] For instance, an infant associates sucking with such pleasurable feelings as hunger, satiety, and being held. These events will be recalled by transferring the sucking action to the most suitable object available, namely, to the thumb or fingers.[17,19]

Perhaps the origin of thumb-sucking eventually will be explained by a combination of the psychoanalytic and learning theories. A combined explanation suggests that all developmentally normal children possess an inherent, biologic drive for sucking. The rooting and placing reflexes are merely an expression of this drive. Furthermore, environmental factors contribute to the transfer of this sucking drive to nonnutritive sources, such as the thumb or fingers.

MAINTENANCE OF THE HABIT

Both theories attempt to explain the maintenance of a NNS habit beyond its adaptive usefulness. The psychoanalytic theory suggests that as children mature they tend to lose autoerotic habits previously associated with early pleasure zones. Thus, it would be expected that most children would cease NNS early in their developmental process (by the age three years). This concept supports the views of previous authors that children who persist in NNS beyond early childhood have some underlying psychologic disturbance.[20-24] This disturbance is viewed as an inability to cope with life's stresses. The child exhibits an anxiety reaction that is often expressed as a type of infantile regression.[20,25] Hence a later stage of development is given up for some earlier, more comfortable period of life during which NNS occurred.

Because digit-sucking, according to the psychoanalytic theory, represents a type of anxiety management by the child, abruptly extinguishing it could be detrimental to the normal emotional development of the child. Furthermore, such treatment could result in substitution of the symptom (NNS) by another behavior.[15,26]

The learning theory assumes no underlying psychologic cause to prolonged NNS. It views all forms of nonnutritive sucking as something that had adaptive value at some earlier developmental stage. The response was subsequently rewarded and eventually became a "learned habit."[27] It follows that direct and aggressive treatment of the habit would not place the patient at risk for symptom substitution.

Despite overwhelming evidence supporting the learning theory, there still exists some evidence that in a minority of patients, a prolonged NNS habit is maintained by some underlying psychologic or emotional disturbance. It seems in most cases that the underlying problem is a result of an acute increase in the child's level of stress or anxiety. Accordingly, one of

An acute increase in the child's level of stress or anxiety can account for continuation of a NNS habit.

the overt signs of the child's attempt to manage the increased anxiety is sustained thumb-sucking. Whether thumb-sucking is a sign of infantile regression is not clear. It has been suggested, however, that an increase in anxiety or stress in a child's life can convert an "empty" thumb habit into a "meaningful" stress-reduction response.[28] Whatever the connection between stress and anxiety and prolonged thumb-sucking habit, direct therapy has been linked to unfavorable results, such as symptom substitution. It is incumbent on clinicians, therefore, to screen patients with an NNS habit properly for possible psychologic disturbances, before initiating treatment.

As with the origin of thumb-sucking, a description of the factors maintaining the prolonged thumb-sucking habit would seem to include components from both the psychoanalytic and learning theories. The combined explanation suggests that prolonged thumb-sucking in most children is a learned habit that found its support through years of contingent positive reinforcement. The response is, thus, a learned behavior that has persisted beyond its adaptive usefulness. Direct therapy of NNS in these children, therefore, is unsuccessful. In a few children, however, thumb-sucking denotes a meaningful activity supported by some underlying psychologic disturbance caused by an acute increase in the level of stress or anxiety. Direct therapy in these instances results in unfavorable consequences for the child.

RISKS

Research has shown that a prolonged digit-sucking habit can have significant effects on dentofacial development. It should be emphasized that the effect is as varied and individual as the method, age of onset and cessation, duration, etc., of the habit itself. In a lengthy electromyographic study of the perioral and masticatory musculature in twenty-four thumb-sucking and finger-sucking patients, Baril and Moyers concluded that "malocclusion caused by thumb-sucking is more a matter of individual response to stimuli than a highly classified cause-and-effect syndrome."[29]

A comprehensive discussion of the dentofacial changes secondary to a prolonged NNS habit is beyond the scope of our article. Instead, any changes, effects, or risks observed, described, or proposed in the literature reviewed are summarized briefly in the Table. It should be emphasized that it is unlikely that a patient with a prolonged thumb-sucking habit will present with all the conditions listed in the Table.

Some spontaneous corrections of the dentofacial effects can be expected, if the NNS habit persists until nine years of age and is then stopped. Larsson reported

Table ☐ Dentofacial changes associated with prolonged nonnutritive-sucking habits.

Effects on the maxilla	Increased proclination of maxillary incisors[6,30,31]
	Increased maxillary arch length[6]
	Increased anterior placement of apical base of the maxilla[6]
	Increased SNA[31]
	Increased clinical crown length of the maxillary incisors[9]
	Increased counter-clockwise rotation of the occlusal plane[32]
	Decreased SN to ANS-PNS angle[6]
	Decreased palatal arch width[19,31]
	Increased atypical root resorption in primary central incisors[33]
	Increased trauma to maxillary central incisors[9]
Effects on the mandible	Increased proclination of mandibular incisors[6,19]
	Increased mandibular intermolar distance[31]
	Increased distal position of B point[34]
Effects on the interarch relationship	Decreased maxillary and mandibular incisor angle[6]
	Increased overjet[6,19,35]
	Decreased overbite[6,19,34-36]
	Increased posterior crossbite[35,37,38]
	Increased unilateral and bilateral Class II occlusion[34-36,38,39]
Effects on lip placement and function	Increased lip incompetence[32,34]
	Increased lower-lip function under maxillary incisors[34]
Effects on tongue placement and function	Increased tongue thrust[34-36]
	Increased lip to tongue resting position[34]
	Increased lower tongue position[31]
Other effects	Risk to psychologic health[25,40]
	Increased risk of poisoning[25]
	Increased deformation to digits[41]
	Increased risk of speech defects, especially lisping[42,43]

that the most striking changes seen are a decrease in dental openbite and retroclination of the upper incisors.[7,8] This spontaneous correction takes place primarily during the first year after habit cessation. The skeletal changes, including the postnormal tendency in the occlusion (Class II skeletal pattern), appear to self-correct to a considerably smaller extent. Hence most of the spontaneous correction seen after habit cessation involves dentoalveolar changes. This information becomes important when attempting to predict the need for future treatment in patients with a prolonged NNS habit.

PREVALENCE

A review of the literature revealed that thumb-sucking and finger-sucking seemed to be influenced by many culturally and socially dependent factors, most notably by child-rearing practices. For instance, Curzon reported no evidence of thumb-sucking in 1,000 Eskimo children from the Canadian Arctic.[44] He pointed out that the Eskimo child is carried on its mother's back all day for up to three years, with a bottle of milk constantly at hand. The author concluded that "accordingly, the opportunity and necessity for thumb-sucking does not exist."[44] It is also interesting to note the inverse relationship between pacifier use and the level of thumb-sucking within the same group. A comparison of the studies conducted in Sweden from 1949 to 1982 demonstrated a decrease in digit-sucking habits with an increase in pacifier use.[3,37,45,46] Gardiner showed that less than 3 percent of children who used a pacifier developed a thumb-sucking habit.[47]

Most of the epidemiologic studies extracted from the literature reported the incidence and contributing factors of thumb-sucking from a sample representative of a specific social and cultural group.[3,30,36,39,44,50] In contrast, Infante sampled children from seventy-four areas in a total of thirty-six states and of the total sample, 18.7 percent of the children reported a finger-sucking habit.[39]

Data acquired from the aforementioned epidemiologic studies suggest that the prevalence of thumb-sucking varies significantly from one population to another. It would seem that any statistical information about the prevalence of sucking habits in a specific sample is conclusive for that population only and cannot be applied to other populations. Because the prevalence of the NNS habit is affected by child-rearing practices, data may become outdated or obsolete as a result of changing parental attitudes. Nonetheless it may be concluded that the prevalence of digit-sucking in North American children at ages two and five is approximately 23 percent and 18 percent, respectively.[39]

CONTRIBUTING FACTORS (VARIABLES)

An understanding of the factors contributing to the NNS habit may aid in identifying those variables that ultimately contribute to the severity (i.e., difficulty in treatment) and maintenance of the prolonged habit.

Gender differences

Honzik and McKee found no gender difference in the distribution of sucking habits during infancy.[49] Beginning with the second year of life, however, the thumb-sucking habit was found to be stronger, more persistent, and more widespread in girls than in boys. Levin and Kaye studied NNS in forty-eight neonates who were sixty-seven hours old and found that the amount of sucking was not correlated with gender or race.[51] These observations suggested that there are no sex-linked fac-

Thumb-sucking and finger-sucking are most notably influenced by child-rearing practices.

tors that account for the sex differences in thumb-sucking habits. If the thumb-sucking habit were somehow sex-linked, differences in levels would be observable shortly after birth. The NNS literature suggested that environmental factors play a more significant role than genetic influences in the gender differences of sucking habits.

Studies by Hanna, Nanda *et al*, and Svedmyr support the findings of Honzik and McKee.[36,46,49,50] The study by Infante also revealed a significant difference in the incidence of finger-sucking between boys and girls.[39] Of the 680 children studied, 23.5 percent of girls sucked a digit, but only 13.7 percent of the boys did. It is also interesting to note that at age five, nine times more girls than boys sucked their thumbs. Backlund found that the distribution between boys and girls with digit-sucking habits was relatively even except in the subgroup of children who engaged in slight sucking at age six or older, in which there were more than twice as many girls as boys.[30] In contrast, Traisman and Traisman found no significant difference in the distribution of thumb-sucking between boys and girls.[48]

Most research supports the finding that girls demonstrate a higher level of NNS and more persistent sucking habits than boys. It seems likely that for most sociocultural groups, more girls than boys require orthodontic treatment for dentofacial deformities caused by NNS habits. Furthermore, the research presented supports the idea that the digit-sucking habit in girls is likely to be more persistent and, therefore, more difficult to treat than in boys.

Influence of age at onset and cessation

☐ *Onset*

Studies by Traisman and Traisman, Roberts, and Brazelton demonstrated that the majority of children with a NNS habit began the habit during the first three months of life.[48,52,53] The rest started during the remainder of their first year. It is not likely, therefore, that children initiate an NNS habit after the first year.

☐ *Cessation*

Every study that linked thumb-sucking with age demonstrated a decreased prevalence of NNS habits with increased age.[3,30,39,45,49]

Breast-feeding versus bottle-feeding

Hanna, in a study designed specifically to investigate the effects of breast-feeding versus bottle-feeding on NNS, found no correlation between thumb-sucking and mode of feeding.[50] Of the 589 children observed, 32.3 percent had a digit-sucking habit. Of those children totally bottle-fed, 31 percent had sucking habits, and 32.2 percent of children totally breast-fed had sucking habits. Of those children breast-fed and bottle-fed, 35.2 percent had a digit-sucking habit. The author concluded that the mode of early feeding was not a significant factor in the development of NNS.

Traisman and Traisman found that of 300 infants (11.3 percent of the total study population) who were fully or partially breast-fed, 43.3 percent sucked their thumbs.[48] Comparing this with the 45.6 percent incidence of thumb-sucking in the total sample, the authors concluded that breast-feeding was not a significant factor in the incidence of thumb-sucking. Backlund also found no difference in the incidence of digit-sucking between breast-fed and bottle-fed children.[30]

It would seem that the mode of early feeding, i.e., breast versus bottle, has little effect on the prevalence of NNS.

Duration of feeding in infancy

Some studies suggest that the length of infantile feeding time influences the development of a thumb-sucking habit. Traisman and Traisman found that the time spent in nutritive sucking was a significant factor in the incidence of thumb-sucking.[48] It was observed that infants who had thirty- to sixty-minute periods of feeding were more likely to form a thumb-sucking habit than those with an average feeding time of ten to twenty-five minutes. This finding supports the earlier observations of Klackenberg and Roberts.[45,52]

Backlund found no correlation between length of the breast-feeding period and thumb-sucking.[30]

Benjamin hypothesized that the deprivation of infantile sucking was inversely related to thumb-sucking.[17] To test her theory, she raised two groups of rhesus monkeys. One group was raised with restrictive nutritive sucking experience (cup-fed) and the other with normal sucking experience (bottle-fed). The group with more nutritive sucking experience showed significantly more thumb-sucking than the cup-fed monkeys. In relating her findings to humans, the author suggested that the rhesus monkeys exhibited NNS in a form comparable to that of humans.

Other factors more influential to thumb-sucking than feeding time, such as pacifier use, may account for the different findings reported in the literature. Despite

the contradictory views presented, most evidence suggests that the duration of early feeding in infancy has little effect on the development of a NNS habit.

Passage to sleep

Wolf and Lozoff demonstrated a correlation between the proximity of the care-giver to the child during passage to sleep and the incidence of object attachment and thumb-sucking.[54] Children who sucked their thumbs were less likely to have a care-giver present as they fell asleep: 32 percent of 150 children who fell asleep alone sucked their thumbs compared with 11 percent of those who had a care-giver present. Furthermore, the authors found that 32 percent of the object-attached children were thumb-suckers compared with 14 percent of non-object-attached children.

Siblings and NNS

Hanna found in his study of 589 pediatric dental patients that the later the sibling rank of a child the greater the chance of having an oral habit.[50] In 1975, Johnson and Johnson conducted a survey of sixty mothers who had 201 children, 60 firstborn and 141 siblings: thirteen (22 percent) of the firstborn and fifty-four (38 percent) of the siblings were thumb-suckers.

Larsson and Järvheden, in a study of 308 children, found no correlation between a NNS habit and the number of siblings, the order of birth, or whether the mother worked outside the home during the child's first years of life.[4] There was a correlation, however, between the level of thumb-sucking and the number of siblings with the same sucking habit. The authors speculated that although it is conceivable that to some extent siblings imitate one another in sucking, the chief reason for the correlation is that the parents influence the habit in their offspring roughly in the same way for all siblings. Larsson and Järvheden confirmed that this was the case with pacifier use.[4]

Colic

Traisman and Traisman found that 45 percent of 282 infants who had colic sucked their thumbs.[48] Because the incidence of thumb-sucking in their total sample was 45.6 percent, the authors concluded that there was no relationship between thumb-sucking and colic. No other study we reviewed considered the association between thumb-sucking and colic.

Socioeconomic

Calisti *et al'*, in a study of 491 preschool children, found that children from a "high socioeconomic group" demonstrated oral habits (finger-sucking, fingernail biting, tongue habits, and lip or cheek habits) more frequently than children from a middle or low socioeconomic class.[56] Wolf and Lozoff found maternal education was related to thumb-sucking: 54 percent of the mothers of thumb-suckers had some college education compared with 26 percent of the mothers of nonthumb-suckers.[54] Likewise, Larsson found that children of parents with an extensive education were more likely to develop a finger-sucking habit whereas children whose parents had little or no theoretical education were more likely to develop a pacifier habit.[3] Infante found that children who lived in a community with a population greater than 2,500 and who came from a middle-class family had a greater prevalence of thumb-sucking than children from a lower socioeconomic class who lived in a community of less than 2,500.[39]

The effect of community size on digit-sucking is likely related to increased levels of education found in larger cities. Moreover, there is convincing evidence that the influence of the educational level of parents on parental response to NNS is probably related to the influence of education on child-rearing philosophy and practice.

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Thumb-sucking: Classification and treatment

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Many articles from multiple disciplines have considered various concepts related to thumb-sucking, also termed "digit-sucking," and "nonnutritive sucking" (NNS). Despite extensive research, considerable controversy exists about many aspects of thumb-sucking habits, especially with regard to treatment. Moreover, no attempt has been made to establish a classification schedule, and little attempt has been made to establish guidelines for the treatment of NNS habits.

The reader is referred to our article, published elsewhere in this issue, in which a comprehensive multidisciplinary literature review of nonnutritive-sucking (NNS) habits is presented. It discussed the causes, prevalence, and risks of these habits and identified factors that contribute to their severity. Building on that article, we propose a clinically usable classification and treatment schedule that allows clinicians to systematically deal with NNS habits.

CLASSIFICATION

Successful treatment of thumb-sucking requires therapy that promotes compliance, favors long-term stability, and is easily adapted to multiple environments. Treatment must be prescribed for the individual habit and must take into account the many factors that contribute to the severity of the habit.

From this complex multivariant description of treatment comes the simplistic notion that most habits respond to a sequential application of increasingly aggressive treatment modalities. Because the assignment of treatment depends on an accurate diagnosis, it seems useful first to propose a simple classification scheme. It is convenient to describe a NNS habit along a spectrum of severity. The criteria for describing this severity are based on the difficulty of treatment. A habit found further along the spectrum becomes increasingly difficult to treat. Because the severity of the habit is based on the ease or difficulty of treatment, the assignment of a habit to a nosologic scheme aids in diagnosis and treatment planning.

There seem to be many factors that contribute to the difficulty encountered in treating these habits. Unfortunately, little or no research supports the definition of these factors. It is necessary to infer correlation, therefore, between these factors and the severity of the NNS habit based on the causes, prevalence, and contributing factors, along with reasoning relative to those studies designed to test different treatment modalities.

The factors that seem to contribute to the severity of the NNS habit in decreasing order are:

☐ *Meaningful versus nonmeaningful habits*

A NNS habit maintained by some underlying psychologic disturbance (meaningful) is more difficult to treat than a nonmeaningful, or "empty," habit.

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☐ *Cooperation of the patient toward habit cessation*
Success of therapy is guarded without patient cooperation. As stated previously, a child may derive enjoyment from the habit and is unwilling to participate in any covert or overt treatment methods. Children who are unwilling to participate in therapy require a more aggressive and different treatment strategy than cooperative children with the same level of thumb-sucking activity.

☐ *Duration of the Habit*
The older the patient, the more difficult it is to treat a NNS habit. The figure demonstrates the characteristic relationship between age and prevalence of NNS as seen in most studies. One explanation for the general decrease in prevalence despite an increase in habit severity is that as a patient ages, there is an increase in factors that promote habit cessation. For instance, with increasing age, there are more social or peer pressures promoting habit elimination. Older patients are also more active, which decreases the availability of the thumb and fingers as well as decreases the opportunity for NNS. Only the more severe habits persist despite an increase in environmental factors that promote cessation. The slope of the curve in the figure flattens from left to right, indicating that although the absolute number of children with this habit decreases with time, a smaller percentage of those remaining have their habit eliminated in each successive year.

☐ *Gender of the patient*
In general, a NNS habit is more severe in girls than in boys.

Habit generalized across multiple settings versus habit localized in one setting A habit generalized across multiple settings occurs at different times and locations during the day, for example, at school and at home. A habit localized in one setting occurs consistently at one specific time and place. There were no specific studies that examined this factor relative to habit severity. A review of treatment approaches, however, strongly suggested that a habit generalized across multiple settings is more tenacious and difficult to treat than a habit isolated at a specific time and place.

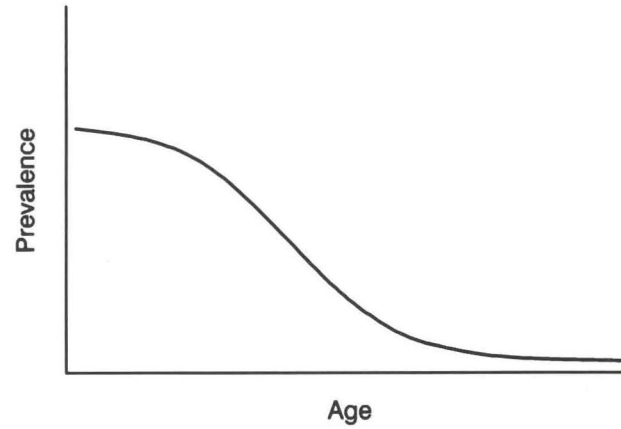

Figure. Characteristic relationship between age and prevalence of nonnutritive-sucking.

☐ *Conscious versus unconscious*
A nocturnal habit or unconscious daytime habit is sustained by unconscious behavior. Simple attenuation of the sensory feedback mechanisms aids in habit cessation. A conscious habit, on the other hand, involves choice or need, making treatment more difficult and complex.

☐ *Cooperation of the parents and older siblings*
A review of studies designed to test treatment modalities demonstrated better treatment results when there was strong cooperation from parents and siblings. Family cooperation, although not affecting the severity of the habit directly, decreases the difficulty of treatment and, therefore, the severity of the habit.

Habits maintained by an underlying psychologic disturbance are the most difficult to treat.

☐ *Previous therapy*

Previous unsuccessful attempts at therapy for NNS habits, especially those of a negative nature, influence later attempts at therapy. In some cases, continuation of the habit is promoted by the attention given by the parent to the child.

Classification would logically proceed from an understanding of the factors that seem to influence the severity of a habit. The classification of NNS habits listed in Table 1 is presented as a series of levels designed to increase in numerical value with increasing habit severity. A (+) or (−) sign is added to each level to indicate the willingness of the patient to cooperate with treatment. A level II (+) classification, for example, may apply to a boy younger than eight years with a NNS habit that occurs across one setting, such as at school or at home or while watching television during waking hours. The patient would demonstrate a fairly high level of desire to break the NNS habit. On the other hand, a level II (−) classification may apply to a similar patient who has little or no desire to stop thumb-sucking.

Table 1 ☐ Classification of nonnutritive sucking habits

Level	Description
Level I (+/−)*	Boy or girl of any chronological age with a habit that occurs during sleep.
Level II (+/−)	Boy under the age of 8 years with a habit that occurs at one setting during waking hours.
Level III (+/−)	Boy under the age of 8 years with a habit that occurs across multiple settings during waking hours.
Level IV (+/−)	Girl under the age of 8 years or a boy over the age of 8 years with a habit that occurs at one setting during waking hours.
Level V (+/−)	Girl under the age of 8 years or a boy over the age of 8 years with a habit that occurs across multiple settings during waking hours.
Level VI (+/−)	Girl over the age of 8 years with a habit during waking hours.

*(+) or (−) designates the willingness of the patient to participate in treatment.

TREATMENT

The proper timing of thumb-sucking treatment is a matter of considerable controversy. On the basis of the age-related development of dentofacial deformities, many authors have suggested that treatment begin at four years of age. These recommendations presuppose that all NNS habits are the same and carry the same risks for the child, which is not the case. It has been suggested recently that the time of treatment be specific for each habit.[1,2] Accordingly, therapy should be postponed until the risks (dental, emotional, psychologic) of the thumb-sucking habit outweigh the benefit to the patient. This does not presuppose that the habit is maintained, however, by some underlying psychologic disturbance in every case, because it is reasonable to assume that the positive reinforcement of the habit (enjoyment) might extend into later years of development. In summary it is reasonable to advise parents that the timing of thumb-sucking therapy depends on the risk profile of the habit. In most cases, treatment for a prolonged NNS habit should be initiated between the age of four years and the eruption of the permanent incisors.

Numerous techniques for habit cessation have been described and studied. Some of the techniques seemed more successful than others in attenuating behavior enough to cause a significant reduction or complete cessation of thumb-sucking. The following is a brief description of the techniques used for habit cessation:

Therapy should begin when the benefit to the patient outweighs the risks (dental, emotional, psychologic).

☐ *Habit Awareness*
Patient awareness of the extent and consequences of NNS and the benefits of habit cessation are enhanced. This technique was covertly used by almost all treatment studies reviewed. Overt use of habit awareness was described by Larsson, McNamara, and Bishop and Stumphauzer.[3-5]

☐ *Punishment using time-out from positive reinforcement*
The philosophy of time-out punishment is the withdrawal of a positive reinforcement during episodes of thumb-sucking and the reinstatement of the positive reinforcer with cessation of thumb-sucking. The positive reinforcement and setting vary among studies but usually consist of watching television or story reading by the parent in the home. Thus, it is claimed that this method is easily adapted to the home setting.[5-8]

☐ *Covert sensitization*
Covert sensitization is a procedure in which a cognitive-induced aversive response is paired with the habit. An imaginary picture of the activity to be eliminated is evoked and then accompanied by a mental image of an aversive response such as nausea.[9]

☐ *Contingency contracting*
A contract of reward or punishment is made contingent on habit cessation or the lack of habit cessation, respectively.[10]

☐ *Prevention of a covarying response*
When the NNS habit is associated with another response, such as trichotillomania (hair pulling), doll holding, ear pulling, etc., treatment of either habit may result in cessation of the covarying response.[11-13]

☐ *Differential reinforcement of other behaviors*
Differential reinforcement of other behaviors (DRO) is reinforcing the lack of the target response, in this case the lack of thumb-sucking. The reward can also be applied to a different but related behavior, such as compliance to habit cessation therapy. If the reinforcement schedule is lengthened as treatment progresses, it is called escalated DRO. In some studies, DRO plus reprimands were used. The reprimands consisted of holding the child, establishing eye contact, and firmly admonishing the child to stop the targeted behavior.[14-17]

☐ *Habit reversal*
The patient is taught some competing response such as clenching the thumbs between the fingers. Whenever the patient is tempted to suck, experiences those activities antecedent to NNS, or is actually thumb-sucking, he or she is instructed to engage in the competing behavior for a count of 50. To be successful, habit reversal is combined with habit awareness, as outlined later.[18-20]

☐ *Sensory attenuation procedures*
Many procedures are designed to interrupt the sensory feedback experienced with NNS.[21] These procedures are divided into appliance therapy and response prevention.

Appliance therapy involves the use of orthodontic appliances to attenuate or to interrupt the sensory feedback.[22-26] Many appliances have been designed to accomplish habit cessation, such as the palatal crib, palatal arch, lingual spurs, and Hawley retainer with and without spurs.[22,23,25,27-34]

Response prevention includes the use of chemical aversion treatment or digit and hand wraps.[7,24,35-40] The use of aversive chemicals on the thumb or finger is relatively ineffective in habit attenuation compared with habit reversal treatment. The faded use of thumb wraps (cotton taped to the thumb or finger) has shown excellent results in treating the unconscious or nocturnal habit.

Treatment steps

In most cases, the NNS habit can be treated with the sequential application of increasingly aggressive treatment modalities. From the above list of treatment techniques, six treatment steps are recommended.

Step l: Screening for psychologic disturbances It is necessary to screen the patient for underlying psychologic disturbances that sustain a thumb-sucking habit. If psychologic maintenance of the habit is suspected, the child should be referred to professionals capable of addressing the emotional component of the problem before active thumb-sucking therapy is pursued.

Step 2: Habit awareness Habit awareness goes beyond a superficial understanding of the cause and effect of thumb-sucking. It stems from the idea that motivation arises from the realization of a positive outcome. In many cases, behavior (i.e., motivation) is maintained longer from the realization of a positive outcome than from the threat of a negative consequence. Accordingly, habit awareness should be accomplished by emphasizing the positive aspects of habit cessation. Of all the steps involved with the treatment of NNS, habit awareness is the most important and should be emphasized.

Several parts are included in habit awareness.

l. With the use of study models, mirrors, etc., children and parents are informed about existing dentofacial deformities and the long-term risks of a sustained

habit. From this seemingly negative platform, patients are presented with positive mental and visual images of the dentofacial ideals expected from habit cessation and subsequent orthodontic treatment. If orthodontic treatment is to follow habit cessation treatment by a few years, it may be helpful to separate the spontaneous changes anticipated after habit cessation from those changes expected from orthodontic treatment.

2. The cooperation of the patient is actively solicited, with a written or at least an oral commitment.

3. Parental cooperation is solicited. Parents serve as the external stimulus in therapy administration; they also covertly monitor the levels of thumb-sucking.

4. Risk settings, i.e., the times and locations when thumb-sucking is most likely to occur, are identified. It is during these settings that the most aggressive and direct therapy is performed, as described in the treatment section.

5. The patient needs to identify those actions, precursor actions, that precede thumb-sucking. This is important for the success of habit reversal therapy.

6. Inconvenience factors are identified, because if therapy causes excessive inconvenience to the child or family, compliance may decrease. These inconveniences are identified and removed, or treatment is altered before implementation.

7. Self-monitoring techniques are introduced. The child is presented with a suitable chart to use in monitoring the lack of thumb-sucking. The chart should accompany the child at each visit. No reward (DRO) is promised at this point.

8. Accountability to the therapist. The dentist serves as a secondary stimulus toward cessation of the habit. The child is instructed to call the dentist at certain intervals during the treatment. The interval between calls should be gradually lengthened (faded) as treatment progresses.

Table 2 ☐ Treatment recommendations for nonnutritive-sucking

Classification levels		Treatment steps: Screening	Habit awareness	Habit reversal	Sensory attenuation	Escalated DRO	Escalated DRO w/ reprimand	Comments
Level I	+	●	●	–	●	–	–	Sensory attenuation using a fading regimen of cotton taped to the offending digit(s) is suggested in most cases.
	–	●	●	–	●	●	–	Escalated DRO contingent on compliance to sensory attenuation procedures listed in Level I (+).
Level II	+	●	●	○	○	–	–	Covert DRO (family praises or social reinforcement) contingent on compliance to habit awareness or habit reversal (if used).
	–	●	●	○	○	●	–	Escalated DRO contingent on compliance to habit awareness or habit reversal (if used).
Level III	+	●	●	●	○	–	–	Covert DRO as in Level II (+).
	–	●	●	●	○	●	–	Escalated DRO contingent on compliance to habit awareness, habit reversal and sensory attenuation (if used) and targeted toward high-risk settings.
Level IV	+	●	●	●	●	–	–	Covert DRO as in Level II (+) and targeted toward high-risk settings.
	–	●	●	●	●	●	–	Same as in Level III (–).
Level V	+	●	●	●	●	○	–	A removable appliance is used for sensory attenuation and enhanced habit awareness. Covert DRO as in Level II (+) and targeted toward high-risk settings.
	–	●	●	●	●	●	○	Escalated DRO as in Level III (–) and targeted toward high-risk settings. Must represent a significant reward to the child.
Level VI	+	●	●	●	●	●	–	Escalated DRO as in Level III (–) and targeted toward high-risk settings.
	–	●	●	●	●	●	●	A fixed appliance is used for sensory attenuation and enhanced habit awareness. Escalated DRO same as in Level III (–).

●, treatment procedure used
○, treatment procedure added as needed
DRO, differential reinforcement of other behaviors

9. The parents are instructed to monitor the child's thumb-sucking. In most cases, this can be accomplished by ratification of the sticker map or chart.

Step 3: Habit reversal The child is taught some type of competing response, contingent on the target behavior, such as grasping the thumbs. The competing response is to be performed to a count of 50 whenever the child is tempted to suck his or her thumb or whenever the thumb-sucking occurs out of habit.

Step 4: Response attenuation Many prolonged NNS habits occur out of unconscious habit. Most treatments incorporate, therefore, some type of habit reminder. For a simple habit reminder, a Hawley retainer or taped thumb could be used. For nocturnal thumb-sucking, a fading regimen of cotton and tape might be used. For the uncooperative severe case, a palatal crib can be used. The literature seems to support the following suggestions about stimulus attenuation:

- ☐ The child should be informed about the purpose of the procedure.
- ☐ The uncooperative child receiving escalated DRO should be reinforced for participating in the response attenuation program or the lack of thumb-sucking.

Step 5: Escalated DRO A positive reinforcement is provided contingent on either the lack of the targeted behavior or another behavior such as compliance to treatment (e.g., wearing tape on the thumb). The reward schedule is gradually faded during treatment. The positive reinforcement must be customized for each child and should concentrate on the high-risk settings.

Step 6: Escalated DRO with reprimand Reprimands, as described above, are added to DRO therapy. Reprimands must be consistent and occur immediately on discovery of the targeted behavior.

The application of the treatment steps depends on the severity of the habit as defined by the level of classification. Table 2 combines the treatment recommendations and classification schedule for the majority of NNS habits. Several useful comments are provided to aid in treatment of habits for each classification level.

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MUTANS STREPTOCOCCI AND CARIES IN PRESCHOOL CHILDREN

Colonization of the oral cavity with mutans streptococci in preschool children is associated with an increased prevalence and severity of dental caries in the primary dentition. Reports indicate that by age 4, as many as 85 percent of children may be infected and that high levels of infection at this age appear independent of racial or ethnic background. Similar results are observed in the current study. Of the 458 3- and 4-yr-olds, 83 percent are infected with salivary mutans streptococci. Of interest is the finding that there are differences in the degree of infection between the study groups. While approximately 40 percent of Black children are considered highly infected, only 28 percent of White children are highly infected. Even though the percentage of infection in Black, Hispanic and White children is similar, the severity of infection varies between the different groups in our study.

The relationship between mutans streptococci levels and caries activity has been reported for several populations of preschool children. Typically, mean dmft and dmfs scores have been shown to increase with increasing levels of mutans streptococci. Results from the current study also suggest a direct relationship between mutans streptococci levels and mean dmfs, with increased levels of infection associated with increased dmfs. The strength of this association is greater in Black and Hispanic children than in White children. Thus for our population, those children who are Black or Hispanic and have high levels of salivary mutans streptococci can be categorized as having the highest level of caries risk.

Different caries disease patterns have been reported in preschool children. Results from the present study suggest that differences may exist between mutans streptococci levels as well as specific disease patterns. Our results show that White children are more likely to be disease free and have less pit/fissure caries than similarly infected Black or Hispanic children.

In conclusion, results from this study indicate that differences in caries activity and disease patterns may exist between populations that have similar mutans streptococci infection levels and socioeconomic backgrounds. Whether the differences in the severity of infection levels, dmfs scores and specific disease patterns are associated with hereditary, environmental or cultural differences in different population groups is not clear.

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DEMOGRAPHICS

Twenty-five years of increasing use of pediatric dental services

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

More children are using dental services. That was the theme of previous presentations in the Journal of Dentistry for Children in the middle years of the 1980s.[1,2] The continuing series of data from the National Interview Survey now confirm further increases in the use of services through 1989. Indeed, information is now available that documents the increasing use of pediatric dental services for the twenty-five years between the mid 1960s through the end of the 1980s.

PERCENT OF CHILDREN WITH A VISIT TO THE DENTIST

In virtually every one of the seven reported surveys and from the youngest child to the teenager, there has been a continuing increase in the percent of children who visited a dentist in the previous year. By 1989 almost a third of children between two and four years of age visited a dentist in the previous year. By 1989 a dental visit in the previous year was reported for 60.5 percent of children between two and fourteen and 69.5 percent of children between five and fourteen years of age (Table 1).

NUMBER OF VISITS PER CHILD

During the past twenty-five year period the increase in the percent of children with a dental visit in the previous year mirrored the increasing number of visits per child (Table 2).*

NEVER VISITED A DENTIST

Most significant has been the decrease in the past twenty-five years in the percent of children who never

*As of this writing in the summer of 1992, an extended review of the pattern of distribution of dental visits by various demographic characteristics has not been reported for the National Interview Survey.

Table 1 ☐ Percent of children for whom a visit to the dentist in the previous year was reported: selected years 1964-1989.[3-5]

Age	1964	1969	1978	1981	1983	1986	1989
2-4					28.4		32.1
< 5*	11.1	11.0	14.3				
2-14					57.9		60.5
5-14	55.1	58.8	64.2	65.2	67.3	71.7	69.5
< 15*	39.6			48.5		53.8	
5-17					67.0	70.3	

* Includes children less than two years of age
Note: The various reports present data in different age-cohorts

Table 2 ☐ Dental visits per child in the past year by age: selected years 1964-1989.[3-5]

Age	1964	1969	1978	1981	1983	1986	1989
2-4					0.7		0.9
< 5*	0.3	0.3	0.4				
2-14					2.0		2.1
5-14	1.9	1.8	2.0	2.0	2.5	2.3	2.5
< 15*	1.6			1.7		2.0	
5-17					2.5	2.4	

* Includes children less than two years of age
Note: The various reports present data in different age-cohorts

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visited a dentist. In the mid 1960s, it was reported that approximately a quarter of children between five and fourteen years of age had never visited a dentist. Twenty-five years later, despite changing dental disease patterns (dramatic decreases in dental caries), the percent of children in the comparable age-group who had never visited a dentist was reduced by almost two-thirds – to 8.6 percent. Similarly there were decreases in the percent of very young children (less than five years of age and children between two and four years of age) who never visited a dentist (decreased to 78 percent and 55 percent, respectively, in the 1980s) (Table 3). Despite these decreases, there is much to be accomplished, however, if we are to reach the American Academy of Pediatric Dentistry's goal which "...urge(s) early parent counseling and dental/oral examinations for all infants, prior to 12 months of age."[6]

GENERAL CONCERNS

While pediatric dentists may express satisfaction with the reports of increased use of dental services during the past twenty-five years, the reality is that there are major reasons for concern. A much broader review of the developing health and social conditions in which children are being reared reveals significant causes for this concern. For example:

- ☐ The number and percent of children living in poverty continued to increase into the 1990s. By 1990, more than a third of the total U.S. population living in poverty was less than eighteen years of age (approximately 13 million children). Almost a half of the black population living in poverty was less than 18 years of age (4.5 million children) (Table 4).
- ☐ After many years of improving rates of immunization of children against a variety of diseases, during the 1980s, there was a slowing and even decreasing rate of these preventive services (Table 5). Note: in 1990, there were almost 28 thousand cases of measles reported, far more than the total number of cases for the years 1981 through 1988. In addition, in 1990, there were more than five thousand cases of mumps, 1,125 cases of rubella (more than the total number of cases for the years 1987 through 1989) and more than 4,500 cases of pertussis (the highest number of cases in any single year between 1979 and 1989 and more than two and a half times the number of cases in 1980).[5]

Table 3 ☐ Percent of children who never visited a dentist: selected years 1964-1989.[3-5]

Age	1964	1969	1978	1981	1983	1986	1989
2-4					64.2		55.0
< 5*	87.0	85.8	82.6	82.2		78.5	
2-14					23.5		19.7
5-14	24.6	17.9	11.6	10.9	10.5	9.3	8.6
< 15*	46.6						
5-17						7.6	

* Includes children less than two years of age
Note: The various reports present data in different age-cohorts

Table 4 ☐ Number and percent of related children under 18 years of age living in a family arrangement with income below the poverty line, and all persons living in poverty by race and ethnicity: selected year 1980, 1985, 1990.[5]

	Number (in millions)				Percent			
	Children			All ages	Children			All ages
	1980	1985	1990	1990	1980	1985	1990	1990
All	11.1	12.4	12.7	33.6	17.9%	20.1%	19.9%	13.5%
White	6.8	7.8	8.1	22.3	13.4	15.6	15.6	10.7
Black	3.9	4.1	4.5	9.8	42.1	43.1	44.7	31.9
Hispanic*	1.7**	2.5	2.8	6.0	33.0**	39.6	38.2	28.1

* May be of any race
** 1979 data

Table 5 ☐ Percent of children age 1-4 years immunized against selected diseases by race: 1970, 1983, 1985.[5]

	White			All other		
	1970	1983	1985	1970	1983	1985
Measles	60.4%	66.8%	63.6%	41.9%	57.2	48.8%
Rubella	38.3	66.3	61.6	31.8	54.7	47.7
DTP*	79.7	70.1	68.7	58.8	47.7	48.7
Polio	69.2	61.9	58.9	50.1	36.7	40.1
Mumps	–	61.8	61.8	–	50.0	47.0

* Diphtheria-tetanus-pertussis

Table 6 ☐ Percent of mothers who were unmarried at the time of the birth of their child by race and ethnicity: 1970, 1980, 1989.[5]

	1970	1980	1989
All	10.7%	18.4%	27.1%
White	5.5	11.2	19.2
Black	37.5	56.1	65.7
Native American	22.4	39.2	52.7
Asian-American & Pacific Islander	8.7	7.3	12.4
Hispanic*	–	23.6	35.5

* May be of any race

- ☐ In 1989 the majority of black, Puerto Rican and Native American mothers of live born infants were unmarried (66, 55 and 53 percent, respectively) (Table 6).
- ☐ During the 1980s, there was a general increase in the percent of live births where prenatal care began in the third trimester or where no prenatal care was provided (Table 7).

- ☐ The number and percent of live births that were "low birth weight" (i.e. less than 2500 grams) rose between 1980 and 1990 (Table 8).
- ☐ Despite decreases in infant mortality rates in the United States, twenty-two countries had lower rates in 1988. The rate in the U.S. was more than double the rate in Japan.[5]
- ☐ As of April 1992 there were 3,692 reported cases and 1,954 deaths (a 52.9 percent fatality rate) of U.S. children less than thirteen years of age from AIDS (Table 9}.

DENTAL CONCERNS

In addition to the variety of examples that raise serious issues about the general health and social potential of youngsters, there are specific dental concerns that should not be overlooked.

- ☐ Studies on the prevalence of nursing caries in the United States through the mid 1980s indicate wide variations by various demographic characteristics, ranging from 5 percent of predominantly black children in a Virginia health clinic, to 11 and 28 percent in Head Start children, and as high as 52 and 70 percent of Native American children served by the Indian Health Service (IHS).[8-10] Amongst the children served by the IHS, 87 percent of those affected by nursing caries displayed the most severe manifestations of the disease.[11]
- ☐ Recent reports indicate a trend toward increasing levels of dental fluorosis, the trend occurring in both fluoridated (a 33 percent increase) and non-fluoridated communities (a ten-fold increase).[12] The additive effects of fluoride supplements, fluoride in one's diet (e.g. baby food and beverages produced in fluoridated areas), fluoride dentifrices, and topical applications during enamel formation may be sufficient to induce cosmetically noticeable fluorosis, even in areas without the addition of fluoridated water.[12]

The 1979 Surgeon General's report, *Healthy People*, identified a series of goals for 1990 related to the dental health of children, including the following:

Goal By 1990 at least 95 percent of the population on community water systems should be receiving the benefit of optimally fluoridated water.

Results In 1975 the proportion of the population on fluoridated community water systems was 60 percent. Between 1975 and 1986, there were virtually no changes in this rate (Table 10). In light of the increasing prevalence of fluorosis, questions are being raised regarding the need to adjust the levels of fluoride in dentifrices and other fluoride containing materials.[12]

Goal By 1990 the prevalence of gingivitis in children six to seventeen years of age should decrease to 18 percent.

Results In 1971-74, the prevalence of gingivitis in this population was 23 percent. While no specific national study reviewed this specific goal for this broad age-group, the 1986-87 national study of school chil-

Table 7 ☐ Percent of live births where prenatal care began in third trimester or where there was no prenatal care by race and ethnicity of mother: 1980, 1985, 1989.[5]

	1980	1985	1990
All	5.1%	5.7%	6.4%
White	4.3	4.8	5.2
Black	8.9	10.2	11.9
Hispanic*	12.0	12.4	13.0
Native American	15.2	12.9	13.4
Asian-American & Pacific Islander	6.5	6.5	6.1

* May be of any race

Table 8 ☐ Low birth weight children (< 2500 grams) as a percent of live births by race and ethnicity of mother: 1980, 1990.[5]

	1980	1990
All	6.9%	7.1%
Total number (millions)	3.8	4.0
White	5.7%	5.7%
Black	12.7	13.5
Hispanic*	6.1	6.2
Native American	6.4	6.2
Asian-American & Pacific Islander	6.7	6.5

* May be of any race

Table 9 ☐ Number of deaths of children (< 13 years) from Human Immunodeficiency Virus by race and ethnicity: 1985-1992.[5,7]

	1985	1990	1991*	Total**
White (non Hispanic)	29	61		402
Black (non Hispanic)	59	197		929
Hispanic	16	62		352
Native American	–	1		5
Asian-American & Pacific Islander	2	1		11
Total***	106	323	265	1,954****

* Partial data available
** Includes all years before 1991
*** Includes all races not shown
**** Includes total number of deaths through the end of March 1992. Data are not available for demographic distribution

Table 10 ☐ Percent of the population on community water systems that received fluoridated water: 1975-1988.[5]

Year	Percent
1975	60.0%
1980	59.3
1985	61.3
1988	61.0

dren fourteen to seventeen years of age reported that the prevalence of gingival bleeding (on gentle probing of the gums} was 58.8 percent.[5]

Goal By 1990 virtually all students in secondary schools and colleges who participate in organized contact sports should routinely wear proper mouth guards.

Results A recent three-year study of about 2,500 adolescent athletes found that 9 percent experienced some form of oral injury. In 75 percent of these injuries, mouth guards were not worn. In 1986-87 the proportion of cranial/facial injuries relative to all bodily injuries sustained from seven reported sports was 5.5 to 16.5 percent.[5]

ON REVIEWING TWENTY-FIVE YEARS OF INCREASING USE OF DENTAL SERVICES

Despite decreasing rates of dental caries, there are continuing indications of increasing use of pediatric dental services. But if there is such a continuing flow of favorable information on the use of pediatric dental services, why would one persist in incorporating data that emphasize the general long-term health and social problems faced by youngsters in our communities?**

The reality is that the use of pediatric dental services is a component of community attitudes and perceptions regarding the value of preventive actions for general health and social services. Rising (or decreasing) expectations and demands for general pediatric services can result from the evolving perceptions of the value of these preventive and curative pediatric services. Whether it be from the perspective of the youngster in need of care, societal awareness of the value of a healthy populous {or even the pecuniary wants of the individual practitioner), the need is to stress continually the strides that have been made and the many goals that remain to be achieved, particularly when there are indications that we may be slipping back on some of our accomplishments (e.g. immunization of our children).

The past twenty-five years have been especially outstanding for pediatric dentistry. What about the next twenty-five years?

**For a more detailed review of many of these problems see earlier presentations in the Journal of Dentistry for Children.[13-15]

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More minority children and the need to stress dental care

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With a surge of new immigrants and *new babies*, (emphasis added) the population of the United States is growing much faster than projected just four years ago.[1]

"Shift toward minorities since 1980 is sharpest for the 20th century."[2]

"...from the dental profession's perspective, the future of pediatric dentistry could rest upon our ability to develop methods to increase services to minority group children."[3]

In a series of earlier presentations in the *Journal of Dentistry for Children,* emphasis was placed on the particular needs for dental and general health services and the limited use of service by minority children, as compared to nonminority children.[3-7] While more recent data continue to reinforce earlier findings related to the limited use of dental services by minority children, minority population projections by the Bureau of the Census add a sense of urgency to the planning process for developing programs to meet the dental needs of these children.[8] The following presentation will review the Bureau of the Census updated projections, results from the 1982 Hispanic Health and Nutrition Examination Survey and the 1989 National Health Interview Survey, and consider the planning consequences for pediatric dental programs and practitioners.

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SOURCE OF DATA

Population projections are based on analysis of eight distinct racial and ethnic groups by the population projection section of the Bureau of the Census.[1] Dental use patterns are based on a continuing nationwide household interview series conducted throughout the year. In 1989, households with 32,357 children were surveyed.[8]

"There has been a dramatic rise in total fertility levels, to almost 2.1 births per woman."[1]

In previous population projection studies, it was assumed that woman in their thirties who had not had children would never have them. The reality is that many older women actually were postponing pregnancies. In addition, the assumption that fertility rates eventually would be the same among varied racial and ethnic groups has been replaced with the view that African-American and Hispanic women will continue to have higher rates of birth.[1] The new population projections indicate that by the middle of the next century virtually half of the population will be made up of African-Americans, Hispanics, Asian-Americans and American Indians. "The current terms, 'majority' and 'minority' will become meaningless."[10]

And further, the Bureau of the Census estimates that legal and illegal immigrants combined will increase the population by 880,000 per year for the next six decades. By the middle of the next century, the population will include 82 million people who arrived in this country after 1991 or who were born in the United States of parents who did.[1]

Whereas earlier projections had estimated that the population would grow to slightly more than 300 million in the next three to five decades, the overall results of the increases in fertility, immigration and longevity will produce a population of more than 380 million in 2050 (Figure). Between 1992 and the middle of the 21st century, the African-American population will grow by 94 percent, the Hispanic population will grow by 237 percent and the Asian-American population will grow by more than 400 percent (Table 1). The number of Hispanics will surpass African-Americans in the next two or three decades.[10]

POPULATION DIVERSITY

In emphasizing the developing diversity of the general population, attention must be directed to the complex nature of each minority group. For example:

- ☐ In current practice, the Hispanic population is classified by country of origin. Almost two-thirds of the Hispanic population is reported as Mexican-Americans, 13 percent as Central or South American, 10 percent as Puerto Rican and almost 5 percent as Cuban.[12]
- ☐ Persons of Hispanic descent may recently have moved to the United States or their families may have lived here for centuries.
- ☐ Hispanics may be bilingual, speak only English, only Spanish or a little of both. In addition, different idioms are used among subgroups, which can make communication confusing among different groups.
- ☐ Different Hispanic patients may be more likely to perceive their illnesses according to prevalent cultural influences, folk practices, and healers. Some Hispanic families emphasize interdependence and cooperation. Thus patients may discuss diagnosis and treatment recommendations with their families before deciding to follow them.[13]

Significant variances exist for the many Hispanic (and other minority populations) subgroups in places of residence, occupations, education, employment, economics, health insurance, and just about any demographic characteristic that can be imagined.*

DENTAL NEEDS AND USE OF SERVICES

Minority populations

There are limited national published data on the oral health status of the general population of Hispanic, Asian Americans, Native Americans, and even less available information on the status of the various subgroups and recent immigrants.[16,17] In the past, reports on epidemiological studies have tended to dichotomize most data into a "white population" and "black population" format, indicating that "other groups" are included in the overall "total" category. More recent presentations have begun to include an "Hispanic" classification (with the note that this grouping includes individuals of any race). Data for Asian-American and Native American

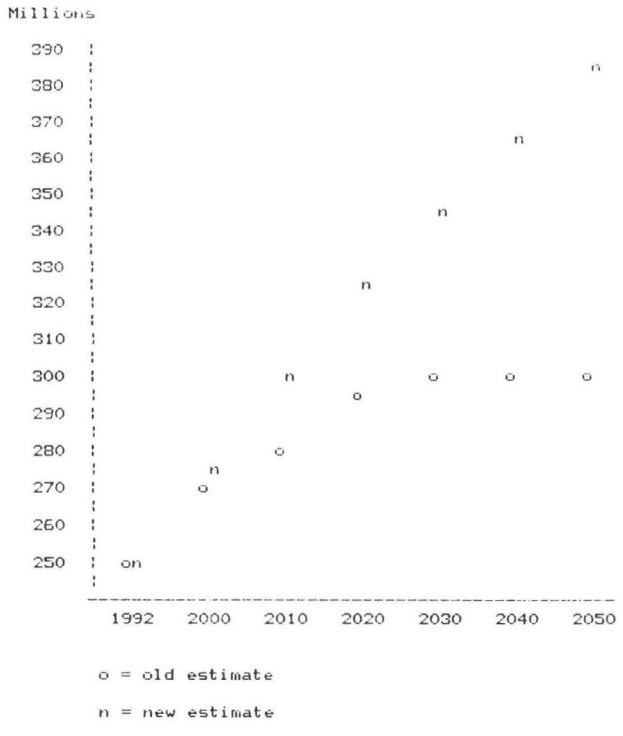

Figure. Population projections: 1992-2050.[1,11]

*See previous publications for a more extensive review of the Hispanic and Asian populations.[14,15]

Table 1 ☐ Percent increase in population by race and ethnicity: 1992-2050.[1]

	Percent increase
All	50.2%
American Indian, Eskimo and Aleut	109.1
Asian and Pacific Islander	412.5
Black	93.8
Hispanic*	237.5
White	29.4

* May be of any race

populations (and subdivisions of these groupings) are seldom if ever recorded separately.

The most recent national study** that collected information on the oral health status of Hispanics is the Hispanic Health and Nutrition Examination Survey (HHANES) conducted by the National Center for Health Statistics between 1982 and 1984.[18-20] (No comparable study for other minority populations has been carried out.)[16]

A summary of the results of the HHANES (reported previously in the *Journal of Dentistry for Children* emphasized 1) higher DMF rates in Puerto Rican children (compared to white and other Hispanic children) and 2) a higher Decayed (D) component of the DMF for all Hispanic children (compared to white children), particularly for Mexican-American children (Table 2).[5] In addition, an analysis of the data for dentate Mexican-Americans indicated that adolescents with low acculturation status (i.e. born in Mexico, spoke and wrote in Spanish only, and they and their parents identified themselves as Mexicans) as compared to other Mexican-Americans, had 1) higher mean number of decayed and missing teeth, 2) poorer oral hygiene, 3) higher prevalence of gingivitis and periodontal disease, and they 1) were less likely to have dental insurance and 2) visited a dentist less frequently.[22]

National populations

Recent nationwide data from the 1989 National Health Interview Survey indicate that:

- ☐ 62 percent of U.S. children (aged 2-17) visited a dentist during the 12 months preceding the interview.
- ☐ 32 percent of children aged 2-4 had a dental visit in the past year.
- ☐ 69 percent of children aged 5-17 had a dental visit during this same period.
- ☐ In each age-group, increased use of dental services was associated with higher family income and the availability of dental insurance.
- ☐ Minority group children were less likely to have had fluoride supplements, used fluoride mouthrinses, and had dental sealant applied to their dentition.
- ☐ African-American children and children in lower income families were more likely to participate in school based fluoride programs.
- ☐ In all age-groups African-American children were less likely to have seen a dentist in the past twelve months than white children.
- ☐ Hispanic children were less likely to have seen a dentist in the past twelve months than non-Hispanic children.
- ☐ "Evidence from preliminary analyses {of dental visit patterns) indicate that racial differences persist even when socioeconomic factors are controlled.[8]

**The study included Mexican-Americans in Arizona, California, Colorado, New Mexico and Texas; Puerto Ricans in the New York City area; and Cuban Americans in Dade County, Florida.

Table 2 ☐ Percent distribution of Decayed, Missing and Filled permanent teeth, total DMF for Mexican-Americans, Cuban Americans, Puerto Ricans and white population: ages 5-17: 1982-1984; 1986-1987.[20,21]

	Percent			
	Decayed	Missing	Filled	DMF rate
Mexican-American*	32.8	1.9	65.2	2.13
Cuban American*	24.6	6.2	69.1	2.07
Puerto Rican*	25.6	3.7	70.6	2.96
White population**	11.7	0.8	87.5	1.97

* 1982-1984
** 1986-1987

Note: The table was reproduced from an earlier presentation in the *Journal of Dentistry for Children*.[5] Care should be exercised in comparing the data from these two studies because of the differing periods of time and the regional nature of the HHANES study and the national scope of the survey representing all U.S. school children.

PLANNING FOR THE FUTURE

"...since 1986, {the dental visit) patterns for disadvantaged groups have not changed."[8]

Under ordinary circumstances, an increasing population of children (and adults†) in need of dental services and a professional group in constant need of new patients (as its former patients "age out") would seem to be a perfect arrangement. But these are not ordinary circumstances. The need is to provide services to an expanding population about which there is limited detailed information on dental disease status; a population that all too often has compromised financial resources, has lacked dental insurance, and has not developed fully a prevention orientation to health services.[8]

If the population projections are correct‡ a series of steps are essential, if the dental profession and indi-

†For an extended discussion of the potential decrease in the dentist-to-population ratios resulting from the forecasted increase in the nation's population and a general stabilization in the number of dental school graduates, see a prior review.[23]

‡As this material was being prepared in December 1992, the Bureau of the Census announced that the nation's population for January 1, 1993 will be 256.6 million people, including 4.1 million births and a net immigration of 846,000 in 1992.[24]

vidual practitioners are to provide services to an increasing diverse population, including:

- ☐ A continuing effort to detail the oral health status of and use of service by the increasingly diverse populations and subgroups that are resident within the country.
- ☐ As the nation and Congress increases its attention to the issues of our health care system, concerted efforts are needed to emphasize the dental needs of the fastest growing and underserved populations.
- ☐ Enhancement of existing efforts in dental schools and post doctoral programs to prepare practitioners to provide services for children (and adults) whose language, culture, and heritage may be quite different from their own.
- ☐ On-going office staff {including practitioners) training programs to prepare a dental practice for "newer populations" that are adding diversity to our communities and dental offices.

In the future, the question will no longer be "...are we so certain of the economic viability of pediatric dentistry that we may overlook minority children?"[4] In the early decades of the next century, as "minority" and "majority" categorical definitions blur, pediatric (and general) dental practitioners will be called upon to provide services to youngsters with an ever changing cornucopia of languages, heritages and cultures. The question to be faced will be, "how prepared are you and your staff to deal with all your patients?"

With apologies to Supreme Court Justice Louis D. Brandeis: "A lawyer (i.e. a dentist) who has not studied economics and sociology is very apt to become a public enemy."[25]

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Appendix

Table A ☐ Projected number of children less than 5 years of age by race and ethnicity: selected years 1993-2050.[26]

Year	White	Black	Am. Indian, Eskimo, Aleut	Asian & Pacific Isl.	Total	Hispanic*
	(in millions)					
1993	15.5	3.2	.2	.8	19.7	2.7
2000	14.4	3.2	.2	1.0	18.9	3.0
2010	14.6	3.5	.3	1.3	19.7	3.6
2020	15.5	3.9	.3	1.7	21.4	4.4
2030	15.4	4.3	.3	2.0	21.9	5.1
2040	15.8	4.7	.4	2.3	23.2	5.7
2050	16.2	5.2	.4	2.6	24.4	6.4

* May be of any race
Note: Totals differ due to rounding

Table B ☐ Projected number of children 5 to 9 years of age by race and ethnicity: selected years 1993-2050.[26]

Year	White	Black	Am. Indian, Eskimo, Aleut	Asian & Pacific Isl.	Total	Hispanic*
	(in millions)					
1993	14.7	2.8	.2	.7	18.5	2.4
2000	15.5	3.2	.2	.9	19.9	2.9
2010	14.4	3.4	.3	1.3	19.3	3.4
2020	15.4	3.8	.3	1.7	21.2	4.2
2030	15.6	4.1	.3	2.0	22.1	4.9
2040	15.7	4.6	.4	2.3	22.9	5.5
2050	16.3	5.0	.4	2.6	24.3	6.2

* May be of any race
Note: Total differ due to rounding

Table C ☐ Projected number of children 10 to 14 years of age by race and ethnicity: selected years 1993-2050.[26]

Year	White	Black	Am. Indian, Eskimo, Aleut	Asian & Pacific Isl.	Total	Hispanic*
	(in millions)					
1993	14.7	2.8	.2	.7	18.5	2.2
2000	15.6	3.2	.2	1.0	20.0	2.8
2010	15.1	3.4	.3	1.4	20.2	3.4
2020	15.3	3.8	.3	1.8	21.1	4.1
2030	16.1	4.2	.3	2.2	22.8	4.8
2040	16.2	4.6	.4	2.6	23.5	5.5
2050	16.5	5.0	.4	2.9	24.8	6.2

* May be of any race
Note: Totals differ due to rounding

Table D ☐ Projected number of children 15 to 17 years of age by race and ethnicity: selected years 1993-2050.[26]

Year	White	Black	Am. Indian, Eskimo, Aleut	Asian & Pacific Isl.	Total	Hispanic*
	(in millions)					
1993	8.2	1.6	.1	.4	10.3	1.3
2000	9.2	1.8	.1	.6	11.7	1.6
2010	9.7	2.1	.2	.8	12.8	2.0
2020	9.2	2.2	.2	1.1	12.7	2.4
2030	9.8	2.5	.2	1.3	13.9	2.8
2040	9.9	2.7	.2	1.6	14.4	3.2
2050	9.9	3.0	.2	1.8	15.0	3.7

* May be of any race
Note: Totals differ due to rounding

Table E ☐ Projected number of children less than 18 years of age by race and ethnicity: selected years 1993-2050.[26]

Year	White	Black	Am. Indian, Eskimo, Aleut	Asian & Pacific Isl.	Total	Hispanic*
	(in millions)					
1993	53.1	10.4	.7	2.6	67.0	8.6
2000	54.7	11.4	.7	3.5	70.5	10.3
2010	53.8	12.4	1.1	4.8	72.0	12.4
2020	55.4	13.7	1.1	6.3	76.4	15.1
2030	56.9	15.1	1.1	7.5	80.7	17.6
2040	57.6	16.6	1.4	8.8	84.0	19.9
2050	58.9	18.2	1.4	9.9	88.5	22.5

* May be of any race
Note: Totals differ due to rounding

ORTHODONTICS

Slow maxillary expansion: A review of quad-helix therapy during the transitional dentition

Robert J. Henry, DDS, MS

Posterior cross-bites are common transverse discrepancies in children, occurring with a frequency of 8 percent to 18 percent.[1-3] The etiology of such problems is multifactorial in nature and is related to genetic, congenital, environmental, functional and/or habitual origins.[4,5] It has been reported that posterior cross-bite, regardless of the stage of the dentition, seldom self-corrects.[1,6] Timely treatment of such transverse discrepancies, during the primary or transitional dentition, is recommended for reestablishment of optimal function in order to normalize dental, skeletal, and neuromuscular growth during these times of active change.[4,7-9]

Treatment by maxillary expansion is widely utilized for the correction of both transverse and arch-length discrepancies. Varying numbers of orthodontic and orthopedic movements are produced during maxillary expansion. The ratio of skeletal to dental change depends on the patient's age as well as the treatment approach used. Three methods frequently employed in the expansion of constricted maxillary arches include rapid maxillary expansion, such as with a Hyrax® appliance (OIS Orthodontics, 65 Commerce Dr., Aston, PA, USA), expansion with use of the inner headgear bow, and slow maxillary expansion with the commonly used quad-helix appliance. Opinions vary as to which approach to employ.[5,7]

Rapid maxillary expansion has historically been advocated for correction of maxillary transverse arch discrepancies.[10-12] With this approach, a jackscrew is activated expanding the appliance from .25mm to .5 mm per day. The objective is to quickly produce transverse arch change by expanding the maxillary midpalatal suture and apical base while minimizing orthodontic tooth movements. It has been shown that such therapy generates approximately equal amounts of skeletal and dental change.[5,13,14] During rapid maxillary expansion, however, appliance activation was found to produce routinely three to ten pounds of force to the maxilla and when multiple daily activation was prescribed, loads of twenty pounds or more were observed.[15,16] Concern over this type of force prompted histologic investigation evaluating possible adverse affects. Results demonstrated the presence of free-floating bone fragments, bleeding, microfractures, cyst formation, vascular disorganization, and connective tissue inflammation in the sutural tissue during rapid maxillary expansion.[17-20] Due to findings such as these, practitioners questioned whether rapid maxillary expansion was the best approach for routine use in growing children.[7,18,21-23] Slower rates of expansion allowing for a more physiologic adaptation of sutures during expansion were advocated.[18,23,24] Interest in the low magnitude force employed in slow maxillary expansion led to development of the maxillary quad-helix appliance.[21,25,26] This fixed expansion appliance was developed through modification of the W arch originally described in 1881.[27] The addition of four helical loops to the appliance provided increased wire length for a greater range in force delivery, allowed for increased flexibility and also provided the ability to correct molar rotations.[7,28] The pur-

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pose of this article is to describe the rationale for use, design and clinical application of the maxillary quad-helix appliance.

INDICATIONS FOR THE QUAD-HELIX APPLIANCE

Indications for maxillary expansion with the quad-helix appliance are similar to those dental conditions where rapid maxillary expansion is recommended. Generally, however, slow maxillary expansion is most appropriate for the patient who presents during the mixed dentition or earlier (Figures 1 and 2). The following is a partial list of indications.

- ☐ For correction of a constricted maxillary arch, with or without posterior cross bite: It has been demonstrated that quad-helix therapy in young patients may result in increases in intermolar width of up to 8 mm.[2,5,20,23] This is particularly effective for the child presenting with a negative or reverse curve of Monson.[29]
- ☐ For correction of a Class II molar relationship: The quad-helix is especially effective at improving a Class II molar relationship, when the maxillary molars present rotated mesiolingually on their palatal roots.[30,31] A distal molar rotation is accom-

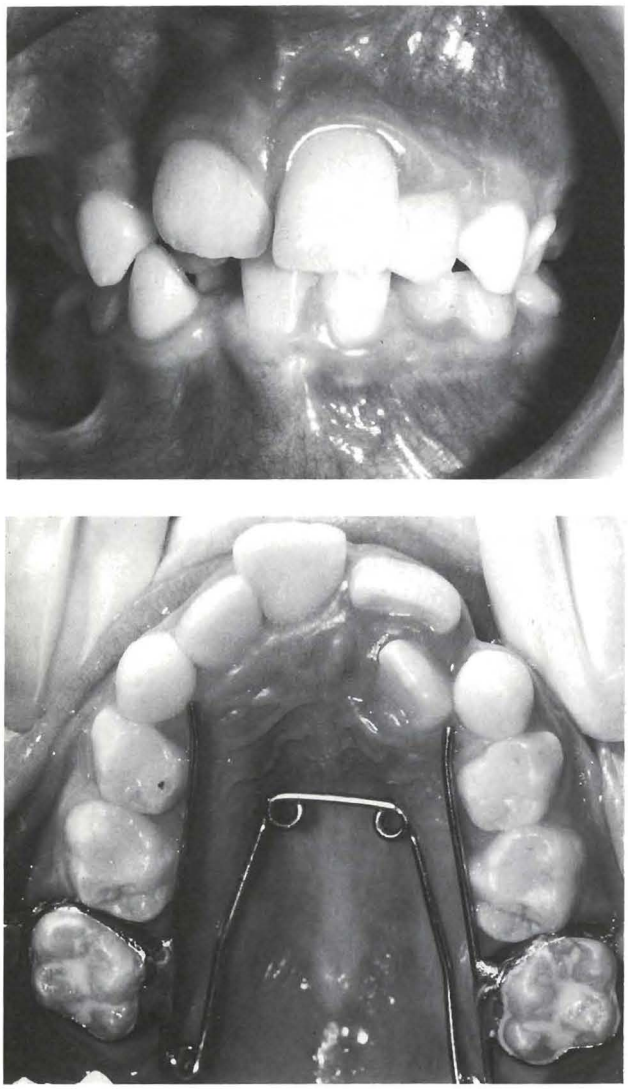

Figure 1 A-B. Pre-treatment frontal view and occlusal view depicting initial placement of the quad-helix appliance. This 9.1 year old white female presented with maxillary arch constriction with substantial crowding. Her maxillary intermolar width was 28.0mm, measured from the gingival aspect of the permanent first molar occlusal lingual grooves, and intercanine width was 29mm, measured from the cuspal tips.

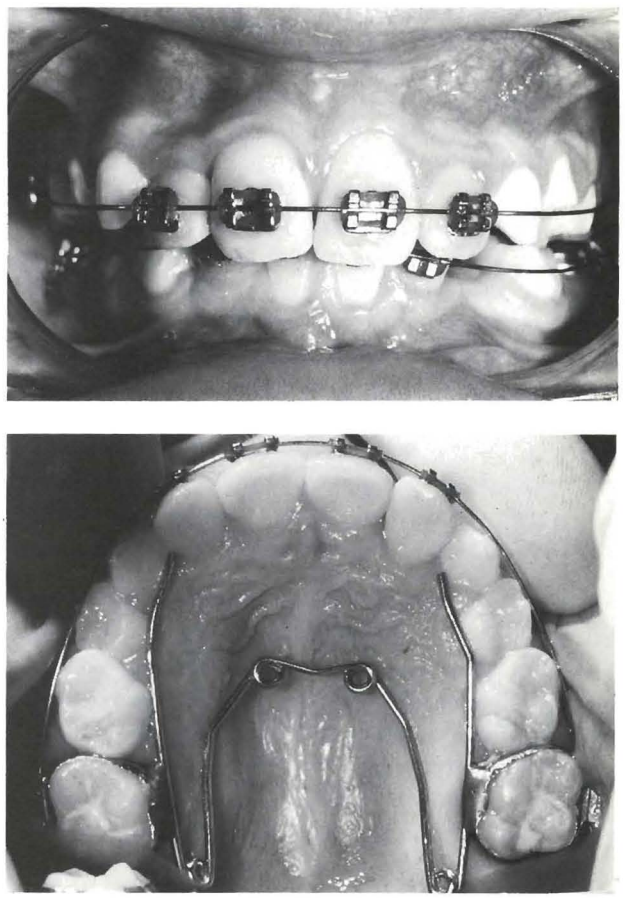

Figure 2 A-B. Post-expansion frontal and occlusal views. The treatment response obtained during the ten-month interval demonstrates an intermolar and intercanine width increase of 5.0mm and 8.0mm, respectively, with minimal crowding evident.

plished during the expansion process by using the palatal roots as anchorage in the Class II dental correction. Maxillary expansion also eliminates any inhibitory influence that maxillary arch constriction may have had on mandibular growth and development. The expansion serves to unlock the malocclusion and allow for subsequent mandibular catch-up growth to facilitate further the Class II correction.

- ☐ For reduction of arch-length deficiencies: Arch perimeter increases of up to 4mm have been demonstrated through early expansion of the buccal segments.[4]
- ☐ For use as a thumb habit appliance: The anterior bridge area of the quad-helix may be positioned to break the sucking seal. This reduces gratification and may eliminate the habit. An auxiliary wire may also be added to the appliance to act as an additional reminder for the child who is ready to discontinue the habit.[32,33]

Upper airway obstruction, as seen with enlargement of the adenoid mass, may lead to oral respiration and open-mouth posture. The influence that mouth breathing and inadequate lip support has on craniofacial growth has yet to be fully established. This condition is generally regarded, however, as undesirable.[34-36] Any positive influence that slow maxillary expansion has on improving nasal respiration is speculative. Rapid palatal expansion though has been shown to produce an increase in nasal width resulting in decreased nasal airway resistance.[5,20,37] The long-term influence that maxillary expansion has with regard to airway improvement remains controversial, but is a consideration for children presenting with such a condition.

APPLIANCE DESIGN

The quad-helix appliance may be obtained preformed, fabricated from 0.038 inch blue Elgiloy wire (Rocky Mountain/Orthodontics: Denver, Colorado), or bent from 0.036 stainless steel. The appliance is fit to the maxillary model and adapted to bands previously selected for and contoured to maxillary permanent first or primary second molars. Placement of separators is advised to ensure proper band selection, because loosened bands have been reported as the most common complication with quad-helix therapy.[2]

Appliance size and positioning before soldering are important for optimal clinical results (Figure 3). The anterior helices are placed on the palatal surface to minimize tongue interference. The anterior bridge should ideally lie on a line joining the distal surfaces of the maxillary primary canines. The posterior helices are placed approximately 4mm posterior to the solder joint area, but not excessively posterior as to impinge on the pterygomandibular raphe. The lateral arms should extend forward to fully engage the primary canine teeth.[30]

During the soldering process the posterior helical loops should be protected from heat treatment. Annealing may result in increasing the stiffness of the wire and the delivery of force by the appliance. This could result in excessive tipping and/or extrusion of the banded teeth: A particularly undesirable treatment response in the vertically sensitive patient.

INSERTION OF THE QUAD-HELIX APPLIANCE

The quad-helix is initially placed passively after removal of separators and completion of a dental prophylaxis. Impingement of the appliance on the soft tissue should be evaluated, with the lateral arms adjusted as needed. The initial activation of the quad-helix is made extra-orally by expanding the appliance 8-10 mm in the molar area, while keeping the buccal arms parallel to one another. This expansion is equivalent to one-half the buccolingual width of the banded molars and results in the lateral arms extending labially to the incisal edge of the primary canines, when viewed passively on the working model.[7] This activation produces a reciprocal force of approximately 450-550 grams, or 14

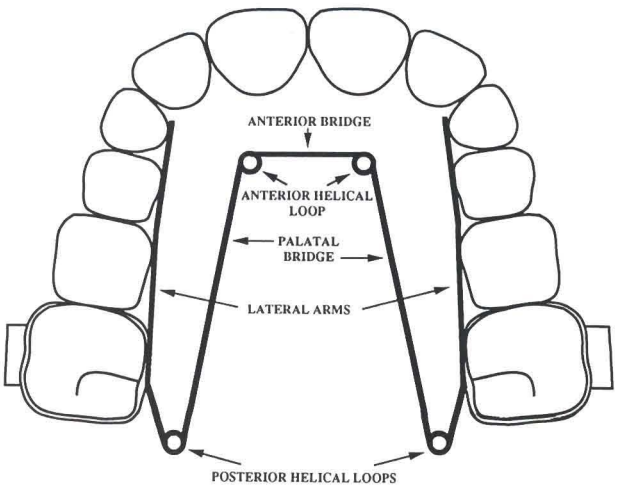

Figure 3. Schematic illustration, during the middle mixed dentition, of the components and design for the maxillary quad-helix appliance.

ounces.[2,22,38] Such a force is sufficient to generate orthopedic movement during the mixed dentition, but only produces orthodontic movement in adults.[2,22,39]

Urbaniak and coworkers demonstrated that arch size, appliance size and patient age are inversely related to the force delivered by the quad-helix.[40] It was found that when the appliance wire type and diameter, typically 0.038 blue Elgiloy, remained constant that proportionately greater force delivery was observed with decreasing arch size, appliance size, and patient age. The authors concluded that significantly less activation of the quad-helix appliance was necessary when treating children who present in the primary dentition.[40]

In situations where substantial mesial rotation of the maxillary permanent first molar is present, one may adjust the lateral arms medially so that they do not contact primary teeth until these rotations have been corrected. This allows for positive distal molar rotation without over expansion in the canine area.[30-31] The quad-helix appliance is inserted active and cemented, using either a glass ionomer or polycarboxylate cement. Final intraoral adjustments of the appliance are performed after cementation, as needed, using a three-jaw plier. Patient and parent instructions are provided and include: dietary restrictions, oral hygiene information, fluoride mouth rinsing instructions, review of possible patient discomforts and speech difficulties as well as a schedule of return appointments.

REACTIVATION

The initial activation put in the appliance is often sufficient to obtain the desired correction. Adjustment of the quad-helix is often required to achieve the desired over-expansion.[2,7] Reactivation of the quad-helix is not recommended until six to eight weeks after insertion. One method to obtain additional expansion and/or molar rotation is through adjustment of the appliance intra-orally using a three-jaw plier. The intra-oral activation is accomplished at three locations (Figure 4). The first adjustment is placed in the center of the anterior bridge with the single beak anterior to the wire. This activation produces expansion in the molar areas. The second and third adjustments are placed slightly distal to the center of the palatal bridge with the single beak placed away from the palatal aspect of the wire. This activation produces expansion of the buccal segments while reducing some of the molar expansion produced with the first bend. Generally intraoral adjustment is accomplished with a smaller anterior bridge adjustment and larger posterior bridge adjustments. This three location activation provides expansion of the buccal segments while enhancing molar rotation in the establishment of a Class I molar relationship. Some evidence suggests that the intraoral adjustment sequence described may produce a progressive decrease in the original activation placed into the appliance.[22] As a result some clinicians recommend that reactivation be accomplished by removing the appliance and expanding it as initially.

Active treatment continues until a 2-3 mm overexpansion has been accomplished. The occlusal inclines of the palatal cusps of the maxillary molars should be in contact with the occlusal inclines of the buccal cusps of the mandibular molars and the arch form should be U shaped.[7] This overcorrection will compensate for relapse of the buccal segments after the retention phase.[20,38]

RETENTION

Active treatment for maxillary expansion, using the quad-helix appliance ranges from forty-two days to ten weeks.[2,7] Treatment time is influenced by factors such as the patient's age, arch-wire size, appliance size, and the amount of activation put in the appliance at the time of insertion.[40] Retention begins when the maxillary expansion has resulted in the required overexpansion.

Properly retained the correction obtained with quad-helix therapy has been shown to be stable.[41] Without retention, however, as much as 45 percent of the correction was found to relapse.[23] The length of retention varies from author to author, but must be of sufficient

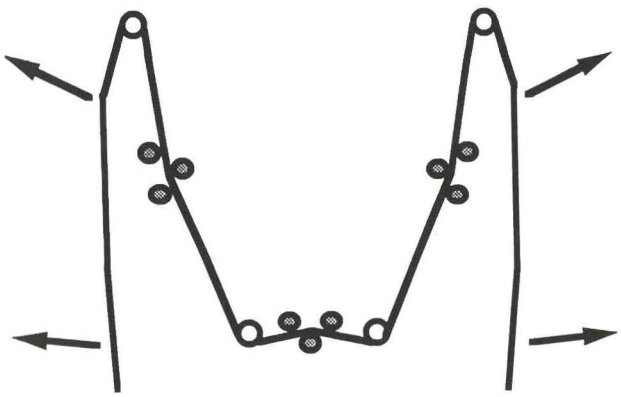

Figure 4. The intraoral activation sequence depicting the location and orientation of the three-jaw plier. These adjustments provide both lateral expansion of the buccal segments and distobuccal rotation of the banded molars.

time to allow for sutural reorganization and stabilization. Retention for two-to-three-month periods has been commonly reported as sufficient to prevent skeletal relapse after slow maxillary expansion.[20,23] Longer retention times may prove to be important for prolonged stability in growing children.

The type of retention also influences the amount of relapse. Fixed retention was found to result in significantly less relapse compared to removable retainers.[23] The quad-helix appliance itself may be used as a fixed retainer at the completion of active treatment. The active appliance may be left in place without removal.[2] As an alternative, when used with a 2x4 appliance, one may remove the palatal aspect of the quad-helix near the solder joint area. The lateral arms of the appliance then act with the 2x4 appliance to retain the buccal segments. Another approach is to remove the appliance after the active phase of treatment, deactivate and recement it passively. Removable retainers may also be used, but have been shown to be less efficient.[23]

DISCUSSION

Slow maxillary expansion has been shown to produce radiographic separation of the midpalatal suture with orthopedic expansion that is evident on frontal cephalogram.[7,23,42] The degree of orthopedic to orthodontic change produced during slow maxillary expansion is variable and dependant upon the patient's age, appliance size, stage of dental development, and the amount of active force in the appliance. Interest in the specific treatment effects produced during maxillary expansion has prompted numerous reports.[4,5,20,43-46] Previous animal and human studies showed orthopedic expansion ranging from 16 percent to 64 percent of the total expansion during slow maxillary expansion.[5,7,19,20,23,41] Although these reports vary considerably, such findings are not unlike results from studies involving rapid palatal expansion.[5,13,14,19] The degree of orthopedic change during slow maxillary expansion is generally thought to be inversely related to the patient's age, with initial dental tipping found to precede the orthopedic separation.[7,23,41]

The transverse arch correction obtained with maxillary expansion is useful for reduction of crowding in cases with deficient arch length.[20] Although the creation of a midline diastema is an unreliable indicator of orthopedic separation, it does demonstrate the positive effect such expansion has on arch perimeter.[4] In addition, unlocking of the malocclusion with maxillary expansion allows for optimal mandibular growth and dental development.[31] Mandibular intercanine and intermolar increases in width, as well as molar uprighting have been shown to occur spontaneously with age, effects enhanced during rapid maxillary expansion.[20,43-47] Although the long-term stability of such effects, as well as their occurrence during slow maxillary expansion have yet to be demonstrated, it would seem reasonable to anticipate similar results with quad-helix therapy performed during the mixed dentition.

In conclusion, slow maxillary expansion with the quad-helix appliance provides an alternative approach to rapid maxillary expansion that is particularly beneficial for correction of transverse and arch-length discrepancies during the mixed dentition. There are numerous indications for this approach with two major advantages. Firstly, a lower force that is within the elastic limits of maxillary sutural and periodontal tissue is generated. Secondly, a separation rate of 0.4 to 1.1mm per week allows for a more physiologic adaptation to the expansion that may result in a more stable correction with less sutural relapse.[7,18,25,30] The quad-helix is a versatile appliance that provides practitioners a convenient means to normalize developing malocclusions.

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