PEDdiATRIC FEEDING diSORDERs: EFFiCACY OF MULTIDISCIPLINARY
INPATiENT TREATMENT OF GASTROSTOMY
TUBE DEPENDENT CHILDREN

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Efficacy of multidisciplinary inpatient treatment of feeding disordered children was sought through retrospective chart review of 40 G-tube dependent children ages 22 months to 7 years. Premature births were 55% of the sample ranging from 23 to 36 weeks gestation. The majority of co-occurring medical conditions included congenital anomalies (50%), gastroesophageal reflux disease (25%) and chronic lung disease (25%). Treatment effect analyzed from pre and post treatment measures of oral and G-tube caloric intakes resulted in a significant difference from admission to discharge for both oral intake, $t(39) = 5.76, p < 0.001, d = 1.02$, and G-tube dependency, $t(39) = 10.94, p < 0.001, d = 2.03$ with both showing strong treatment effects. Results indicated a highly reliable and valid method of treating severe pediatric feeding disorders.
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INTRODUCTION

Feeding disorders of infancy and early childhood lack standard diagnostic criteria and methods across both medical (Burklow, Phelps, Schultz, McConnell, & Rudolph, 1998) and psychiatric spectrums (Chatoor, Getson, Menvielle, Brasseaux, & O’Donnell et al., 1997) which has been cited as an obstacle to treatment and research (Chatoor, Ganiban, Harrison, & Hirsch, 2001). Although there are no universally accepted definitions of common feeding problems (Arts-Rodas & Benoit, 1998; Lindberg, Bohlin, Hagekull & Palmerus, 1996; Skuse, 1993; Rommel, DeMeyer, Feenstra & Veereman-Wauters, 2003), it has been estimated that up to 25% of normally developing infants and up to 80% of those with developmental disabilities are affected (Chatoor, Hamburger, Fullard, & Rivera, 1994; Lindberg, Bohlin & Hagekull, 1991; Wolke, Meyer, Ohrt & Riegel, 1995). Feeding resistance is often severe enough to require enteral feeding for nutritional support (Dellert, Hyams, Treem, & Geertsman, 1993) and may involve a conditioned dysphagia in children (DiScipio, Kaslon, & Ruben, 1978). Distressing experiences involving the mouth, nose, throat and esophagus have been said to result in behaviors resembling phobic responses seen in posttraumatic stress and has been termed posttraumatic feeding disorder (Chatoor, Conley, & Dickson, 1988; DiScipio et al., 1978; Griffen, 1979). Such behaviors include arching backward, squirming, crawling away, crying, gagging, coughing, retching and vomiting (Benoit & Coolbear 1998). Aversive and avoidant responses to feeding resulting in feeding problems has been estimated to affect 40% of infants who have had esophageal surgery (DiScipio et al., 1978) and 4% of those with gastroesophageal reflux who do not have a neurological or craniofacial problem or a history of esophageal surgery (Dellert
et al., 1993). Due to the severity of problems, enteral feeding such as gastrostomy tube (G-tube) is often initiated for physiologic reasons during a time of medical crisis or when a child’s nutrition needs cannot be met through oral intake (Schauster & Dwyer, 1996).

Transition from enteral feeding to oral feeding and establishing normal eating behavior in children who have required long term G-tube feedings can be very challenging due to the complex interaction of biological, psychological and environmental factors which combine to disrupt healthy infant development. Feeding is a highly integrated, multisystem skill and often one or more contributing systems may be dysfunctional (Rommel et al., 2003). Therefore, previous attempts to reduce the disorder to a simple organic/nonorganic dichotomy have been unsuccessful (Bithony, Junkin, & Michalek, 1989; Budd, McGraw, & Farbisz, 1992). The multifactorial causes involve a substantial behavioral component (Bonnin & Claude, 2006) that regardless of concurrent physical factors (e.g. cardiorespiratory, metabolic, neurological or structural) includes up to 85% of children with feeding problems (Burklow et al., 1998). Clinical observations have revealed that some infants and young children who had undergone traumatic experiences to the oropharynx or esophagus subsequently refused to eat and demonstrated severe distress before feeding (Chatoor et al., 1988, Chatoor et al., 2001). It has been reported that aversive experiences surrounding feeding result in avoidant responses to eating to escape the anticipated pain, discomfort or intense anxiety (Arts-Rhodas & Benoit 1998; Benoit, Green, & Arts-Rhodas, 1997; Chatoor et al., 1988; Hyman, 1994). Due to the significant behavioral component of feeding disorders, behavioral therapy has been established as an empirically supported treatment of the broad spectrum diagnosis of feeding disorders (Kerwin, 1999).
More specifically, research demonstrating the efficacy of behavioral treatments on reducing G-tube dependency and increasing oral intake have focused on operant learning principles due to the multisystem interaction of the biological, psychological and family system involvement in the onset and maintenance of adaptive mealtime behavior (Babbitt, Hoch, Coe, Cataldo, & Kelly et al., 1994; Benoit & Coolbear, 1998; Benoit, Wang, & Zlotkin, 2000; Byars, Burklow, Ferguson, O’Flaherty, Santoro, & Kaul, 2003). Behavioral treatments shown efficacious in research include escape extinction (Benoit et al., 2000) positive and negative reinforcement, shaping, discrimination, fading and parent training (Babbitt et al., 1994; Benoit & Coolbear, 1998; Byars et al., 2003).

Historically, punishment and reward contingencies alone have shown little influence on classically conditioned feeding behaviors (Werry & Wollersheim 1989). However, systematic desensitization and extinction have been shown to be highly effective with phobias surrounding food refusal (Babbitt et al., 1994, Benoit 1998, Byars et al., 2003; Kerwin, 1999). Behavioral treatments involving extinction (i.e. flooding) alone resulted in 47% of patients no longer dependent on tube feeding as compared to 0% in the control group receiving nutritional counseling alone (Benoit et al., 2000). Studies which utilized a combination of behavioral techniques including positive and negative reinforcement, shaping, discrimination, fading, parent training and extinction report from 44% (Byars, et al., 2003) to 86% (Babbitt et al., 1994) of patients taking all nutrition and hydration orally by discharge. It should be acknowledged that individualized treatment planning is necessary in a behavioral treatment paradigm. It is also likely that what has been researched and reported are actually interaction effects of multiple components (e.g. speech and occupational therapy) that go into successful treatment outcome and not
simply behavioral techniques. For example, oral sensory impairments addressed by speech therapy not only impact oral motor skills, but also often produce avoidance responses to varied types of stimulation, and may manifest behaviorally as generalized irritability (Arvedson & Brodsky, 2001 297).

Previous studies have focused on removal of G-tube and dependency as the major variable signifying treatment efficacy and success. Only one study measured caloric intake as a treatment variable (Byars et al., 2003) while others focused on volume of intake (Babbitt et al., 1994) or G-tube removal (Benoit et al., 2000). Utilizing caloric intake provides a more specific measure as opposed to mass or volume (Byars et al., 2003). Caloric intake provides a better assessment of nutrition which can be used to make decisions about reduction of G-tube feedings. In order to adequately demonstrate the effectiveness and efficacy of treatment it is necessary to demonstrate specificity along a continuum (Jacobson, Follette, & Ravenstorf, 1984) rather than the simple dichotomy of G-tube dependency versus no dependency. In multidisciplinary treatment settings it is important to establish a single outcome measure which spans across disciplines. In light of this, the following study sought to extend the literature on the efficacy of multidisciplinary treatment of pediatric feeding disorders through analysis of treatment and magnitude of effect on oral caloric intake and reduction of G-tube dependency. It was hypothesized that combined treatments of speech therapist, occupational therapist, dietician and a pediatric psychologist would result in significant increases in oral caloric intake and reduction of G-tube dependency. Based on previous clinical observations, it was also hypothesized that no significant differences would be found in weight from admission to discharge.
METHOD

Participants and Procedures

Retrospective analysis was conducted on all infant and children in-patient feeding records from Our Children’s House, Baylor, Dallas, Texas from 2001 to 2005. All patient records were included in the final analysis if they were receiving gastrostomy tube feedings for nutritional support. Patient records were not excluded for any other reason. This resulted in a total of 40 patients including 20 males and 20 females ages 22 to 84 months ($M = 47.88$, $SD = 16.29$). Demographics by race indicated 68% Caucasian, 15% Hispanic, 7% African American and 10% listed as other. A large portion of the sample (55%) were premature births ranging from 23 to 36 weeks gestation with an average of 29 weeks ($SD = 4.02$). Co-occurring medical conditions were diverse (Figure 1). The term “co-occurring” is used to further describe the complexity of medical conditions without implying a known etiology of the feeding disorder. This study was performed with the appropriate approvals of the Internal Review Boards for both the University of North Texas and Baylor Research Institute.

![Diagram showing the distribution of co-occurring medical conditions](chart.png)
Figure 1. Within the complete sample of 40 children, 50% had a congenital anomaly resulting in medical intervention at birth such as surgery, tracheotomy and ventilation. Congenital problems included diaphragmatic hernia, hyperplastic lung, intrauterine growth retardation, short bowel, tracheo-esophageal fistula, tetrology of fallot, hypoplastic heart, Cerebral Palsy (CP) and various syndromes such as Down, DiGeorge, Monosomy 21, Ring 15 Chromosome, and coloboma, heart anomalies, choanal atresia, retardation of growth and development, and genital and ear anomalies (CHARGE). Within the congenital group, 35% of children also had a diagnosis of gastroesophageal reflux disease (GERD). Children in the sample diagnosed with GERD alone were 25%. Children with chronic lung disease comprised 7.5% of the sample. Lastly, 17.5% of the sample and did not fit any particular category but included various medical problems including, cancer, respiratory syncytial virus (RSV), meconium aspiration, kidney reflux, anoxic encephalopathy and failure to thrive of no specific origin.

Total days of hospitalization ranged from a 15 to 80 day period ($M = 46.43$ days, $SD = 0.45$ days) and varied due to individual rates of progress. The first three days served as the pre treatment outcome measure for each child’s average oral caloric intake and G-tube requirements. These three days were used as a treatment control as no formal treatments were implemented allowing time for speech and occupational therapy, dietary and behavioral assessments to be completed and recommendations made to inform treatment planning. During this initial three day period, parents were not involved with any program activities and the children were given an opportunity to adjust to the hospital setting, staff and routine.
BASELINE PERIOD: DAY 1 THROUGH 3

Assessment

*Speech therapy evaluation.* Oral motor and oral sensory skills were assessed by observational evaluation completed by licensed speech therapists. Speech therapists determined oral motor skills for eating and drinking, oral sensory status and safety of swallow. A Modified Barium Swallow Study (MBSS) was conducted to assess dysphagia. In terms of skills, speech therapists assessed range of movement, strength, coordination, patterns of movement and alignment of the lips, tongue, jaw and cheeks. Abnormal or inadequate skills which would interfere with the patient’s ability to orally manipulate food and liquid were identified for treatment. For example, if a patient exhibited abnormal jaw and tongue patterns, they may have difficulty chewing solids and forming a cohesive bolus.

Often children who have been exposed to aversive medical treatments or have experienced oral sensory deprivation due to G-tube feedings exhibit oral sensory disorders (Arvedson & Brodsky, 2001, p 297). Therefore, oral sensory evaluation was crucial to a complete speech therapy evaluation. This part of the evaluation inspected the patient’s tolerance to textures, consistencies and flavors and the subsequent impact of oral motor skills and behaviors. Hyposensitive, hypersensitive or sensory defensive responses were identified. These responses are known to interfere with the patient’s ability to discriminate oral sensory input accurately and may impair oral motor skills (Arvedson & Brodsky, 2001, p. 295).

*Occupational therapy evaluation.* Occupational therapy assessed each child’s ability to process sensory information and provide an adaptive response through
participation in age-appropriate activities (Miller, 2007). This was accomplished with both standardized parent report and clinical observation of self-care skills, and responsivity to tactile, vestibular and proprioceptive sensory input. Caregiver report was obtained using the Infant/Toddler Sensory Profile (IFSP) (Dunn & Daniels, 2002) and the Sensory Profile (SP) (Dunn, 1999). DeGangi and Greenspan (1989) Test of Sensory Function (TSF) was completed by occupational therapist. The standardized testing, clinical observation and parent/caregiver report were combined to determine areas of sensory processing difficulties.

**Dietary evaluation.** Nutrition status was assessed using rate of weight gain and overall growth chart trends (Center for Disease Control, 2000). For example, adequate weight gain for 2-6 year old boys is 5-6 grams/day and 5-7 grams/day for girls. Goals for children ages 6-10 years of age are 6-10 grams/day for boys and 7-12 grams/day for girls. Individual considerations including weight, oral intake, age, rate of progress, and phase in feeding program were considered when deciding to reduce enteral feedings.

**Behavioral Assessment.** Direct observation by licensed pediatric psychologist was completed while each child was fed or attempted to be fed a meal by the parent or primary caregiver. Assessment involved a functional analysis of behavior with identification of probable antecedent and consequent controlling variables (Linehan, 1977, p31). The determination of strengths, skills, reinforcers, significant others, competing contingencies and possible problems related to modifying the behavior(s) of interest were considered during behavioral assessment (Gambril, 1977; Mash & Terdal, 1976).

**Treatment Planning**
Speech therapy treatment. Once evaluation was complete, speech therapists analyzed the patient's oral motor and oral sensory skills and established menus, feeding utensils, bite size and drinking protocol to be used during meals. Feeding skills were communicated to the feeding team to ensure consistent reinforcement of expected skills. These components of the feeding protocol were addressed in speech therapy sessions which were held daily and separately from the structured meals. Speech therapy treatment consisted of activities to facilitate increased success in oral feeding. The four general target areas that the speech therapists addressed during treatment sessions were increasing oral motor skills, normalizing oral sensitivity, increasing the volume of foods accepted, and increasing the variety of foods accepted.

Common oral motor deficits addressed are decreased strength, range of motion, and precision and/or speed of movements involving jaw, lingual, and labial musculature. Some treatment activities targeting deficits with the jaw included chewing on a variety of foods (e.g., soft solids, meltable crunchy foods) and oral motor tools (e.g., chewy tubing), using bite blocks to hold sustained closed jaw postures and demonstrating controlled jaw movements by slowly and rhythmically opening and closing a clothespin held with the upper and lower central incisors. Various lingual exercises included resistance exercises in which the participant pushes his or her tongue against a tongue depressor held by the speech therapist and movement activities in which the participant demonstrated protrusion, elevation, depression and lateralization of the tongue in response to a stimulus (e.g., lollipop, tongue depressor, or taste of preferred smooth food on a spoon). Deficits with labial musculature were addressed through a variety of movement exercises in which the participant was required to create pressure with the
labial musculature while using an aid (e.g., lollipop, straw, whistle), repeatedly open and close his or her lips on a tongue depressor, and demonstrate repetitive alternating protrusion and retraction of the lips.

Speech therapy attempted to normalize oral hypersensitivity in order to increase the participants’ acceptance of a variety of textures. Oral sensory activities include providing sensory input to the oral cavity (i.e., tongue, cheeks, roof of mouth, teeth) through toothettes, nuk brushes, nuk brushes with texture (i.e., flavored sugar such as Pixie Stix), and vibration.

The speech therapists addressed increasing the volume of foods accepted by slowly increasing the bite size of a preferred food during treatment sessions. To accomplish this, the speech therapists slowly built up the bite on the participant’s spoon (the same type of spoon used in meals) at a slow enough rate that the participant did not consistently refuse. In order to achieve this goal, behavioral treatment strategies provided by the pediatric psychologist were used during treatment sessions. Once the participant consistently accepted a specific bite size during speech therapy sessions, this bite size would be required during meal times. The speech therapist also adjusted the spoon based on the participant’s success. For example, when a participant successfully accepted full, heaping spoonfuls from a baby spoon, the therapist moved up to a toddler spoon and again slowly built up the bite size on that spoon.

Speech therapy used the same procedure as above when increasing variety of foods. If a food was non-preferred, the therapist offered only a dip of that food on the spoon and slowly moved up to a full spoon based on the participant’s success and acceptance. In some cases the therapist would mix a preferred food with a small
amount of non-preferred food when after multiple attempts over several therapy
sessions the child did not accept even a dip of the non-preferred food on the spoon.
Once the child accepted a preferred/non-preferred mixture of food, the speech therapist
slowly weaned out the preferred from the mixture. Again, foods were not added to the
menu until it was consistently accepted during speech therapy sessions.

    Occupational therapy treatment. Individualized treatments targeting difficulties
with specific sensory input were developed. Treatment focused on sensory integration
interventions designed to enhance the brain's ability to accept and process sensory
information and ultimately to create an adaptive response (Ayers, 1972). Equipment and
activities used during treatment were designed to help children receive information
through their senses, modulate their nervous system according to the sensory input,
and participate in adaptive responses or the desired task more successfully (Ayers,
1989). Occupational therapy was provided daily for 30 minutes, three to five times
weekly, utilizing the equipment and techniques designed by Ayers (1989). Tactile
treatments included brushing and joint compression for reduction of tactile
defensiveness. A variety of food and non-food textures were used for tactile exploration,
generally progressing from dry/smooth, to dry/rough, to wet/smooth, and to wet/mixed.
Activities were play-based and the overall goal was to decrease not only the tactile
hypersensitivity, but the negative associations with food. Vestibular difficulties were
addressed with various swinging and balancing activities. Proprioceptive problems were
addressed with activities involving brushing, joint compression and high impact activities
to help increase body awareness and calm the child.
**Dietary treatment.** To optimize oral caloric intake, food items were calorie boosted with calorie dense commercial additives and nutrient dense beverages were encouraged. Tube feedings were transitioned to a continuous overnight schedule to promote hunger and optimal oral intake. Caloric intake was determined using strict daily calorie counts. Intake of food, beverages, and calorie boosting items were measured in grams and recorded at each meal. The amount of food consumed and the ratio of food items to calorie boosters was calculated into the calorie counts. Calorie, protein, and fluid intake was recorded and used in conjunction with weight trends to wean tube feedings. As progress was made with increases in oral calories, reductions in tube feedings were made by decreasing the hours in overnight continuous feeds. This was a more conservative reduction than attempting equivalence in reduction of G-tube with amount of increase in oral calories. For example, continuous feedings were reduced by ending completion time at 3AM from 4AM as progress was made in treatment. At a common rate of 150cc per hour this would result in an average reduction of 200kcal., ranging from 150kcal. to 225kcal.

**Behavioral treatment.** Each individualized behavioral treatment program was designed to help the child overcome difficulties and move forward by addressing behaviors that have manifested as a result of the identified deficits and previous experiences surrounding medical problems. Positive and negative reinforcement and extinction were the primary behavioral techniques used. Positive reinforcement was provided when the child’s responses to presentation of food were appropriate meal-time behaviors. Such behaviors included allowing food in and around the mouth, chewing and swallowing. Positive reinforcement included (but was not limited to) social praise
and a few seconds time to play with a favorite item or watching a favorite children’s movie/program. Extinction (i.e. ignoring and not withdrawing the presented item) was used for aversive responses such as crying, gagging, vomiting, retching, arching backward or throwing food. Therapists remained neutral in their response to these behaviors and continued to offer the food for a 30 minute period. After the 30 minute period the child was told the meal was over and that they may try again at the next meal. Behavioral treatment was broken into four phases with movement from one phase to the next dependent upon the child’s progress with oral caloric intake and team evaluation. Things that either hindered or accelerated treatments were: food accepted with minimal refusal; volume increased, weight remained stable so that G-tube could be decreased; and parents were demonstrating the ability to implement that stage of treatment with minimal cuing.

**MULTIDISCIPLINARY FEEDING TREATMENT: DAY 4 THROUGH DISCHARGE**

*Structured Behavioral Feeding Treatment*

*Phase one (observation).* Multidisciplinary feeding treatment was managed by social and psychological services. A total of 5, 30 minute structured meals were provided every 2 hours daily. Behavioral treatments, menu items, seating and utensils were designed and implemented according to previous assessment recommendations. Meals were provided in a special feeding room with a one-way window for parents and other professional and medical staff to observe. Feeding therapists were licensed speech therapists, speech therapists working on their graduate degree and students working on their doctoral degree in clinical health psychology. All therapists were additionally trained and supervised by the on-staff licensed psychologist. Medical and
nutritional oversights were provided by the registered dietician, pediatric physician, and nursing staff. All food items were weighed before and after meals. Daily caloric intakes were calculated monitored by a registered dietician. All changes in nutritional intake via G-tube were assessed as part of a multidisciplinary team process with increases or reductions prescribed by the physician in charge with on-going monitoring by all team members to insure adequate nutritional intake and the safety of each child. All necessary G-tube feedings were typically accomplished over night in order to break the contingency of hunger/satiety with G-tube feedings. Speech therapists initiated oral motor and oral sensory therapies. Occupational therapists initiated sensory, gross motor and fine motor therapies.

The focus of this phase of treatment was to begin changing some of the behavioral habits the child had developed. The focus was not only feeding behaviors, but the child’s response to limits in general. These patterns are typically well established with caregivers and therefore it was necessary for the caregivers to observe without the child’s knowledge during the day. Therefore, each child participated in therapies and feedings during the day without caregiver involvement. Parents/caregivers began observing feeding sessions and some therapy sessions from behind a one-way mirror. Observations were done initially with the psychologist, case manager or therapist. This started the caregiver training process with explanations provided on the philosophy of the behavioral treatments utilized during the feeding sessions.

*Phase two (participation in therapy).* The focus of this phase of treatment was to introduce caregivers back into the daily routine. Caregivers were introduced into the meals once the child adjusted to the routine and began to progress in the feeding
sessions. This was done during a therapy session (as opposed to a feeding session) to reduce the potential of disrupting the progress made during meals. This allowed the child to become accustomed to seeing the caregiver or parent during treatments while still maintaining the same level of participation. Disruptions from introduction of the parent/caregiver into the routine were worked through during this time. For example, this time was spent enhancing positive reciprocal interactions with appropriate timing of reinforcement such as social praise and playful activity as well as setting limits and expectations in a therapeutic setting.

Phase three (participation in feedings). The goal of this phase was to maintain progress with the parent in the room. Caregivers were introduced into the feeding room once the child demonstrated an increase in intake of food, decrease of disruptive behaviors in the feeding, and adjusted to participation in therapy sessions. Caregivers initially observed from the back of the room and moved closer to the child over time. Caregivers continued to separate 15 to 30 minutes prior to the meal and were situated in the room prior to the feeding therapist bringing the child into the room. Praises were permitted with verbal cueing from the therapist or by following the lead of the therapist.

Phase four (caregiver feeding). Caregivers began feeding meals during the final phase of treatment. Caregivers participated in all aspects of feeding including meal preparation and accompanying the child to the room. The feeding therapist initiated each meal and allowed the caregiver to complete the last half of the feeding session with the parent gradually taking over the entire meal. Therapists continued to provide training and feedback during this time. For example, parents were given feedback on reciprocal responses and guided in remaining neutral, not withdrawing food and
ignoring avoidant or aversive responses. Parents were also assisted with appropriate timing of reinforcement such as social praise and playful activity.

This phase was usually five to seven days prior to discharge. The focus was to assist the caregiver with the training necessary to transition the progress with oral intake and reductions in G-tube to the home environment. Although follow-up services were provided after discharge, data from this service was not available analysis.

**Statistical Analysis**

A paired sample t-test was performed using the Statistical Program for Social Sciences (SPSS). Analysis of differences in oral caloric intake from Day 1 to Day 3 was tested with paired sample t-test in order to support the validity of this time frame as a baseline control period. No analysis of G-tube reductions were performed as tube feedings were altered only by changing to overnight, continuous feeding.

Analysis of treatment outcome was assessed with paired sample t-test comparison of pre treatment and post treatment weight, oral caloric intake and gastrostomy tube caloric intake. Analysis was computed for Cohen’s $d$ and achieved power using G Power (Buchner, Erdfelder, & Faul, 2001) analysis for computing difference between two dependent means (i.e. matched pairs) with a .5 correlation correction. Oral and G-tube outcome measures were calculated using the average of the initial 3 days inpatient as the pretreatment measures. This was done in order to control for error in parent report and establish hard nutritional data on each child. The outcome measure for post oral caloric intake was computed as the average of the last 5 days of treatment. All analyses were conducted at the 95% confidence level. Post hoc analysis was completed for age and length of inpatient treatment.
RESULTS

Results of t-test calculations of differences in Day 1 oral calories ($M = 479.72 \text{kcal., } SD = 365.4\text{kcal.}$) to Day 3 oral calories ($M = 549.41, SD = 437.38\text{kcal.}$) resulted in no significant differences $t(39) = 1.66, p = .10, \text{CI} (-154.61, 15.24)$, supporting further analysis using this time period as a treatment control.

Results of t-test calculations of differences between pre treatment gastrostomy tube caloric intake ($M = 703.65\text{kcal., } SD = 233.11\text{kcal.}$) and post treatment gastrostomy tube caloric intake ($M = 211.04\text{kcal., } SD = 251.21\text{kcal.}$) resulted in a significant reduction in gastrostomy tube dependency, $t(39) = 10.94, p < 0.001, \text{CI} (401.52, 583.69)$. Magnitude of the effect of treatment ($d = 2.03$) and post hoc power ($\beta = 1$) on reducing gastrostomy tube dependency were both very strong.

Results of t-test comparison of differences between pre treatment oral caloric intake ($M = 542.21\text{kcal., } SD = 375.05\text{kcal.}$) and post treatment oral caloric intake ($M = 897.83\text{kcal., } SD = 312.27\text{kcal.}$) resulted in significantly increased post treatment oral caloric intake, $t(39) = 5.76, p < 0.001, \text{CI} (-480.50, -230.74)$. Magnitude of effect of treatment ($d = 1.02$) and post hoc power analysis ($\beta = .99$) again, were strong. A total of 42.5% of children were taking all meals and nutritional needs orally at the end of treatment.

Results of the paired sample t-tests resulted in no significant difference in pre treatment weight ($M = 13.5\text{kg, } SD = 3.33\text{kg}$) and post treatment weight ($M = 13.56\text{kg, } SD = 3.0\text{kg}$), $t(39) = 0.279, p = 0.782$.

Group differences by age were analyzed with an independent sample t-test. Infants and toddlers ages up to 48 months of age ($n = 19, M = 215.24\text{kcal., } SD = \ldots$)
287.74kcal.) and children in our sample over 48 months to 7 years of age \( (n = 21, M = 193.24\text{ kcal.}, SD = 216.27\text{ kcal.}) \) showed no significant differences in post treatment G-tube reduction, \( t(38) = 1.08, p = 0.287 \). Levene’s test of equality of variances indicated equal variances could be assumed \( (p = 0.234) \). Independent t-test analysis on differences in post treatment oral nutritional intakes between ages 48 months and less \( (n = 21, M = 925.585\text{ kcal.}, SD = 349.22\text{ kcal.}) \) and children over 48 months to 7 years of age \( (n = 19, M = 867.16\text{ kcal.}, SD = 271.80\text{ kcal.}) \) also resulted in no significant differences in treatment outcomes by age, \( t(38) = 0.586, p = 0.561 \). Levene’s test for equality of variance was met \( (p = 0.274) \).

Inpatient treatment ranged from 15 to 80 days with an average stay of 46.43 days \( (M = 46.43, SD = 10.15) \). Post hoc analysis was completed splitting the groups by those in treatment less than the average stay and those requiring treatment longer than the average stay. Children in treatment for less than 46.63 days did not perform differently on post treatment oral caloric intake \( (M = 992.67, SD = 238.97) \) than children requiring treatment longer than 46 days \( (M = 846.77, SD = 338.63), t(38) = 1.43, p = 0.161 \). Levene’s test of equal variances was met \( (p = 0.213) \).

**DISCUSSION**

This retrospective study demonstrates strong treatment efficacy for multidisciplinary treatment of G-tube dependent children. The magnitude of effect of treatment was very strong for both increases in oral calorie consumption \( (d = 1.02) \) and decreases in G-tube caloric requirements \( (d = 2.03) \) with 42.5% of the children taking all nutrition orally at discharge. It should be noted that the baseline pre treatment caloric measure may have negatively influenced the true effect of treatment outcome as these
numbers are generally an underestimate of progress. For example, this baseline estimate does not take into account the increase in oral intake from home to day one or day three. Although no therapeutic interventions occur during the three day baseline period, it is well known that change of environment and controlling parental contingencies can alter well established behavior patterns (Chatoor et al., 1997; Lucarelli, Ambruzzi, Cimino, D'Olimpio, & Finistrella, 2003). Statistical analysis from day 1 to day 3 resulted in no significant differences in oral caloric intake or G-tube reduction, providing additional support for using this period as a baseline pretreatment period. This also indicates that decrease in G-tube feeds (usually between 120-240ml) that is implemented on admission is not sufficient enough to provide a treatment effect.

Analysis of changes of weight resulted in almost no change at all from pre and post treatment. This is not surprising given the 46 day average length of hospitalization. A similar study used percent of ideal body weight as an outcome measure and reported weight loss during treatment with gains in weight at several months follow-up (Byars et al., 2003). Percent of ideal body weight (e.g. weight for height) for each child could have been a better measure of treatment effect. However, the goal of inpatient treatment was not to increase weight but rather to maintain weight during the intensive treatment. The maintenance of pre treatment weight signifies a carefully controlled balance of G-tube reduction to oral consumption. Careful monitoring of caloric intake provides the treatment team with the specificity necessary to inform nutritional recommendations (Byars et al., 2003). This also allows for necessary alterations to G-tube caloric intake in order to create a motivational setting for treatment (Linscheid, 1999) which often cannot be done safely at home.
Treatment effects for children less than four years-old were not significantly different than children over four years. It is interesting that creating the dichotomy of young versus old did not lead to significant age related effects as both age (Illingworth & Lister, 1964) and length of time on G-tube (Blackman & Nelson, 1985; Linscheid, 1992) have been shown to influence treatment outcome. Age has also been significantly correlated with an increase in behavioral problems with feeding (Rommel et al., 2003). Age groups in the present study were dichotomized due to small sample size which was a limitation of our study for this analysis. Future research is needed to establish the validity of earlier intervention for transition to oral feedings.

Analysis of length of stay did not yield significant outcome differences between those who required more than the average length of inpatient stay ($M = 46.43$ days) and children requiring less. These results are indicative of a heterogeneous population which responds to treatment at various rates. The results are reflective of the medical team decision which was based on individual need. This demonstrates that treatment was not related to predetermined length of stay but rather on each child’s individual progress. Children were discharged based on meeting the treatment goals. This is important information for insurance companies as often economic contingencies require changes in treatment practices (Babbit et al., 1994). Determination of length of treatment is best accomplished by individual needs assessed by the medical team. This research and future research can serve to inform insurers of the competency of medical team determinations of treatment necessity rather than predetermined time requirements for goal accomplishment.
Previous research on transitioning gastrostomy tube dependent children to oral feedings has primarily been single subject designs (Babbitt et al., 1984; Blackman & Nelson, 1985; Blackman & Nelson, 1987; Farrell, Hagopian & Kurtz, 2001; Gutengag & Hammer, 2000; Luiselli & Luiselli, 1995) or focused on volume of intake (Babbitt et al., 1984; Benoit et al., 2000). Only one other study was identified that utilized the specificity of caloric intake as an outcome measure (Byars et al., 2003). This was a strength of the present research. Although case studies are beneficial, larger group studies show generalizability of treatment effects to a broader patient population with diverse medical etiologies and backgrounds.

Some limitations of the study should be noted. This research was a retrospective review with common caveats in final analysis. The initial three days of admission were utilized as a baseline as typically there was no formal treatment during those first three days. However, it should be acknowledged that changes in environment and caretakers alone could have a strong effect on children’s responses to eating. Retrospectively, the effect of environmental change from home to hospital could not be assessed as data were not collected from the family on oral and G-tube caloric intake prior to admission. It is also well known that many contingencies are built between the caretaker and the child which serve to maintain adverse behavioral responses to eating. These contingencies are immediately interrupted with the change to a professional feeder. Future prospective studies could incorporate a multiple baseline design across settings from home, to hospital, to reintroduction of the caretaker into the feeding role, and back to home. This would be similar to a more traditional ABAB design in which multiple-baselines are obtained across behaviors (e.g. caloric intake) and situations. Multiple-
baselines could address the effect of environment and caretaker on treatment outcomes and provide stronger evidence of true treatment effects. The extent to which the treatment effects may be extended or generalized outside of the inpatient setting should also be investigated through longitudinal follow-up of the children in their natural home environments. Lastly, it is strongly encouraged that future research incorporates a control group comparison for strengthening the internal validity of the results found in the present retrospective design.

It should also be noted that other therapies such as speech language therapy, physical therapy and child life activities may begin outside of mealtime during the first 3 days. It is difficult if not impossible to account for the amount of influence of general rapport building, and the setting of therapeutic and behavioral expectations that other therapeutic interactions may have on the mealtime process. Prior therapeutic experience may have influenced the rate of change for both skill acquisition and behavior modification lending to a more positive outcome. We acknowledge that some children may have received other professional and therapeutic services on an outpatient basis prior to inpatient treatment. However, this information was not available for analysis in the present study. Research is needed on outpatient treatment efficacy and the effect (e.g. rate of change) on inpatient treatment. Although such information would be highly informative, no empirical evidence was found which suggests outpatient treatment is beneficial prior to consideration of an intensive inpatient feeding program.

A multidisciplinary team approach is essential for assessment and management due to combined medical, oral, sensory and behavioral components of pediatric feeding problems (Bonnin et al., 2006; Burklow et al., 1998; Rommel et al., 2003). Speech and
occupational therapy were an integral part of the treatment process, as behaviors surrounding feeding are often the result of oral motor skills deficits, sensory dysfunction and sometimes pain. Therefore, the success of multidisciplinary treatment cannot be measured by reduction in negative behaviors alone. The present study did not seek to emphasize or validate any one behavioral technique over another. Behavioral therapy of children with severe feeding disorders is a dynamic process involving well established patterns of child behavior and parental contingencies. Throughout the treatment process many major and minor modifications in technique are required, as no two cases are exactly alike and because behavior itself changes as treatment progresses (Linscheid, 1999). In multidisciplinary treatment settings it is a false assumption that treatment effects can be circumscribed to a single component, discipline or technique. Rather, the focus should be the same for all treatment team members with clearly defined goals and outcomes. An optimal patient outcome is the result when this is accomplished with many of the multisystemic problems greatly ameliorated. As shown by this retrospective review, multidisciplinary inpatient treatment is a highly reliable and valid method of treating severe pediatric feeding disorders of diverse etiologies. In this light, the present study supports continued collaboration of medical science and behavioral science in treatment of gastrostomy dependent children.
REFERENCES


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