FACTORS INFLUENCING MYOELECTRIC WEARING PATTERNS
OF PEDIATRIC PROSTHETICS PATIENTS

DISSERTATION

Presented to the Graduate Council of the
University of North Texas in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Shannon M. Glenn, B.A., M.S.
Denton, Texas
December, 1996
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Upper limb deficiencies in children may be the result of trauma, disease, or congenital problems. Although biomechanical losses are the primary problem associated with a limb deficiency, the loss of such an obvious body part has cosmetic and psychosocial implications as well. Fitting a child with a prosthesis typically is the treatment chosen by families. Presently, there are three types of prostheses available for pediatric amputees, including passive, cable-operated, and myoelectric arms, but the myoelectric appears to be the most popular choice of children and their families. However, there is growing concern among clinicians that, despite its advanced technological capabilities, the myoelectric prosthesis is chosen for aesthetic rather than functional reasons. It is difficult, then, to justify the expense of fitting a myoelectric prosthesis when a more inexpensive prosthesis, or none at all, would be a more appropriate prescription. The question of when to prescribe a myoelectric prosthesis for a pediatric patient remains one of the most controversial questions in the field of prosthetics today due to this
cost/benefit issue. In this study, the researcher examined psychological factors that may influence whether or not a child will wear a prosthesis and how that prosthesis will be used. Thirty prosthetics patients of Texas Scottish Rite Hospital for Children and their parents answered questionnaires indicating self-perception, social acceptance, and family functioning. A prosthetic usage diary also was completed. Results indicated a significant relationship between optimal residual limb length and increased wearing time. Other trends in the data are discussed. Consideration of these variables by medical staff can be useful in developing appropriate expectations of adherence to treatment by the patient and the family. Recommendations are made for the prescription of pediatric prostheses that are both cost-effective and beneficial.
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CHAPTER I

INTRODUCTION

The birth of a child typically is a joyous occasion, with cause for celebration among family members. However, the birth of a baby with a defect of any kind can negatively affect this family experience, particularly for the parents. Physical defects, including congenital limb deficiencies, are startlingly obvious and may elicit any number of responses from parents and other family members. The parents are faced with treatment issues that often are decided during infancy, though they may have little knowledge upon which to base their decisions.

Limb deficiencies in children may be the result of trauma, disease, or congenital problems (Setoguchi & Rosenfelder, 1982). The true incidence of congenital limb deficiencies, however, is unknown (Mason, 1991). Krebs and Fishman, in a 1984 survey of the Association of Children’s Prosthetic-Orthotic Clinics, reported that, in children, congenital deficiencies are twice as common as acquired amputations and most congenital deficiencies involve the upper limbs. The authors noted, also, that males have a slightly higher incidence than females of both congenital and acquired limb deficiencies.
According to Aitken (1972), biomechanical losses are the primary problem associated with congenital limb deficiencies. Mason (1991) added that the loss of such an obvious body part has cosmetic and psychosocial implications as well. Fitting a child with a prosthesis of some sort typically is the treatment chosen by families and physicians alike.

Ideally, an upper limb prosthesis should compensate for the loss of fine, coordinated hand movements, provide some tactile sensation and proprioceptive feedback, and have an aesthetic appearance (Millstein, Heger, & Hunter, 1986). Currently there are three classes of prostheses available for an upper limb amputee: passive, conventional, and myoelectric. The passive prosthesis is simply a cosmetic replacement with a passive, or nonfunctional, hand, while the conventional prosthesis includes a body-powered and cable-operated appliance with a split hook or hand as a terminal device. The myoelectric prosthesis is an electrically-powered prosthesis controlled by muscle sensors or micro switches, also with a hook or, more often, a hand as a terminal device.

Myoelectric prostheses have been in use with adult patients since the 1950’s; however, due to the size and weight of the components, they were not prescribed for children. Also, during this time, young children were considered unable to learn to operate the hand (Hambrey &
Withinshaw, 1990). Thus, it was common practice not to fit children with any prosthesis until school age.

Technological advances and smaller components developed during the early 1970’s, however, resulted in the availability of myoelectric prostheses for children. Since 1971, young children with upper limb deficiencies have been fitted and trained with myoelectrically controlled prostheses (Sorbye, 1977, 1980).

Advantages of the Myoelectric

Cosmesis

The usefulness of carefully prescribed electrically powered components in the rehabilitation of upper extremity amputees long has been recognized (Schmidl, 1973). According to most clinical experts, the greatest advantage of electrically powered prostheses is that they provide a desirable level of cosmesis (Mifsud, Naumann, & Milner, 1987). Cosmesis, or cosmetic function, is considered to be the natural appearance of the prosthesis and the degree of unobtrusiveness with which the amputee can use it (Van Lunteren, Van Lunteren-Gerritsen, Stassen, & Zuithoff, 1983). As these authors noted, for the majority of users in their study of 42 adult unilateral amputees, the cosmetic function of the limb was very important. Likewise, research with other adult patients revealed cosmesis and the lack of physical exertion as the major advantages cited by wearers of myoelectric prostheses (Northmore-Ball, Heger, & Hunter,
1980; Verstappen, Thuring, & Mulder, 1972). Mifsud, Naumann, and Milner (1987) reported that, with myoelectric design, the size and shape of the prosthesis are considered carefully in an effort to foster acceptance through enhanced self-image and the positive perceptions of the family.

A number of studies have shown that the myoelectric arm is preferred over a conventional prosthesis for cosmesis, whether or not it is used effectively (Menkveld, Novotny, & Schwartz, 1987; Tervo & Leszcynski, 1983; Trost, 1983). For example, in a study of 25 children, three to five years of age, fitted with a child-sized hand prosthesis, the major advantage perceived by the children was the device's hand-like appearance (Krebs, Lembeck, & Fishman, 1988). These authors noted that virtually all the children and their parents reported more favorable reaction by the children and their peers to the hand rather than a hook. Anecdotal data from this study revealed that some of the once-shy children became more willing to participate in social activities and less inhibited when meeting strangers. In addition, other studies have shown that the choice of a myoelectric over a conventional prosthesis was based primarily on the appearance of the myoelectric, as reported by the child, but often with the agreement of the family (Crone, 1986; Glynn, Galway, Hunter, & Sauter, 1986; Mendez, 1985; Sorbye, 1980; Weaver, Lange, & Vogts, 1988).
Further, the willingness of the children to wear the prosthesis generally increased following the replacement of the original terminal device (usually a hook) with a hand. Millstein, Heger, and Hunter, (1986), suggested that, in addition to preferring its appearance, the children were better able to identify with the shape of a hand, rather than a hook, and the concepts of using the device were understood better, fostering more effective and longer wearing patterns. These authors also have stated (Millstein, Heger, & Hunter, 1982) that a lack of concern with appearance should be a contraindication to fitting an amputee with a myoelectric prosthesis.

Physical Advantages

Other prosthetists cite the lack of a harness as a major advantage of the myoelectric prostheses (Herring & Cummings, 1996). The harness, needed with body-powered or conventional prostheses, can be uncomfortable and will limit the range of motion permitted. With a myoelectric, a level of comfort is enjoyed and the limb is functional in a variety of body positions, allowing more freedom of motion. Other authors (Millstein, Heger, & Hunter, 1986) noted these same physical advantages of the myoelectric as well as superior pinch force and more natural control.

Additionally, Agnew and Shannon (1981) indicated that the application of sensory feedback in the form of touch sensation may enhance the acceptability of the myoelectric
device. Some sensory feedback has been reported by wearers between the residual limb and the prosthesis, the vibration of the motor and controlling muscle contrast (Millstein, Heger, & Hunter, 1986).

Fitting a Prosthesis

Generally it is believed that the probability of acceptance of a conventional, manually operated prosthesis is increased, the earlier the prosthesis is fitted (Brooks & Shaperman, 1965; Rodgers & Scott, 1980; Sypniewski, 1972; Wilson, 1970). Most clinicians recommend that congenital amputees be fitted with their first prosthesis soon after they are able to sit alone (Michael, 1990), but there is some support for fitting as early as three to four months of age (Rodgers & Scott, 1980; Sypniewski, 1972). Specifically, researchers suggested that early fitting establishes an acceptance of and tolerance for the limb, helping the child to incorporate the limb into the body image. Early fitting also encourages bilateral movement patterns and promotes better use and skill development (Angliss, 1974; Brooks & Shaperman, 1965; Rodgers & Scott, 1980; Sypniewski, 1972; Wilson, 1970).

Some authors, however, have suggested a developmental progression for the prescription of a prosthetic device for pediatric patients as they mature. Rodgers and Scott (1980) recommended the initial fitting of a passive infant hand within the first few months of life, in order to establish
acceptance and a consistent prosthetic wearing pattern. Withrow and Schuck (1991) described a former policy of the Shriner's Hospital in Greenville, South Carolina, under which the majority of patients were fit as infants with conventional, body-powered prostheses. A change in the philosophy of the institution, however, has resulted in the initial fitting of infant patients with a passive hand, then a myoelectric one site, one function prosthesis (called a "cookie crusher"), and, finally, with a traditional myoelectric prosthesis. It is the recommendation of the facility now that patients be fit initially with the same type of terminal device that will be used later, for instance, a type of hand. Likewise, in a review of the last ten years of the infant fitting program at the Prosthetics Research Centre in New Brunswick, researchers reported fitting with a passive prosthesis infants as young as four months of age (Stocker, Caldwell, & Wedderburn, 1992). The children then are fit with passive prostheses weighted in three stages until the device reaches the approximate weight of a myoelectric. The decision to switch the child to a myoelectric, sometimes as early as the first birthday, depends on the progress and development of the child and the family during the passive fitting period.

Fitting a Myoelectric Prosthesis

Despite the consensus that initial fitting of some kind of prosthesis should be done at an early age, considerable
controversy exists as to the most appropriate and effective age at which myoelectric fittings should be done (Sorbye, 1980) for pediatric patients. Sorbye (1978, 1980) reported that the most successful fittings seem to be with children between 2½ and 4 years of age. He indicated that fitting a child at this age coincides with normal psychomotor development and promotes the integration of the limb into the child's body image. Sorbye also suggested that, for both parents and their children, the cosmetic myoelectric hand is more acceptable psychologically than a hook apparatus, which provides additional support for fitting a myoelectric device as early as possible in order to insure acceptance by parents and child. Finally, Sorbye (1977, 1978, 1980) reported that early fitting results in an avoidance of the atrophy of stump muscles resulting in better control sites, better quality of muscle signals over a greater area, and better socket retention. Other researchers (Mendez, 1985; Crone, 1986) have agreed. Mendez (1985) reported the successful treatment of children between the ages of 3½ and 4½ with a myoelectric prosthesis, noting that 60% of these children wore the device continuously and used it effectively. The parents of these children indicated that their own expectations were fulfilled and, in unsolicited comments, said that their children had gained psychologically from the use of the myoelectric prosthesis. Crone (1986), in a single case study, indicated a beneficial
myoelectric fitting for a child of 17 months, noting greater functional use of the prosthetic limb than even that of the natural, or contralateral, limb. After reporting the positive results of another single case study (Greenberg & Dralle, 1991), the authors concluded that a myoelectric device must be considered as a viable prosthetic option for young children, although it would not be appropriate for all of them. These authors hypothesized that the function of the myoelectric is comparable to that of the hook apparatus, as each has advantages for specific activities, but the cosmetic appearance of the hand seems to enhance the child's body image. The authors also suggested that the increased parental acceptance of the myoelectric prosthesis was likely to facilitate wearing and increased usage. They noted that often a prosthetist really is "fitting the parents," although myoelectric devices may be too expensive for providing only cosmetic function.

Scott (1992), in a summary of the results of a multi-center survey, noted agreement among participants that fitting a patient with a myoelectric by three or four years of age enhances the probability of long-term use. However, only very limited support was indicated for the necessity of even earlier myoelectric fitting. Other researchers have noted that difficulties may arise when fitting these young children (Colburn, 1977; Shaperman & Sumida, 1980; Sorbye, 1977, 1980). For example, the battery may have to be placed
externally, resulting in a large and bulky forearm. Also, a more sophisticated understanding of cause and effect and a longer attention span may be required in order to train the child to use the prosthesis effectively. Trost (1983) recommended that, despite some studies suggesting children as young as two years of age can be fit with myoelectric prostheses, children under the age of 10 should not be prescribed such devices. This author noted that a child's prosthesis is not as durable as a result of the structural concessions necessary to adapt a child-sized hand from adult size and may be damaged easily, requiring frequent repair. He also suggested that the younger child, less concerned with the appearance of the apparatus, is not likely to make the adjustments required to prevent breakage. Menkveld and Novotny (1986) reported, from their study of 21 children, ages 3 to 18, fit with myoelectric devices, that no subject under 9 years of age wore their myoelectric prosthesis for more than 7 hours daily (the length of a typical school day) and most discontinued all use of the prosthesis within six months. The most common complaint among the subjects in the Menkveld and Novotny study was the weight of the device, which the younger subjects found burdensome after even short periods of time. These authors recommended no routine prescription of a myoelectric prosthesis before the age of nine. Trost (1983) suggested fitting children with a myoelectric prosthesis after the use of a conventional body-
powered prosthesis, between the ages of 9 and 11, when the child is old enough to make the choice and to commit to one year of myoelectric wear.

Clinicians (Ballance, Wilson, & Harder, 1989) also have expressed concern at the use of the myoelectric by young children outside the clinic setting, noting that, with their patients, the hand was not worn full-time and tended to be used more passively, as a stabilizer. They observed that many of the younger children, when standing, used their sound hand to support the weight of the myoelectric arm. Some researchers have recommended that myoelectric fittings not be done until the early teens (Rodgers & Scott, 1980; Verstappen, Thuring, & Mulder, 1972) because the adolescent patient would be strong enough to carry effectively the weight of the limb, large enough to be fit with readily available adult components, and mature enough to provide the attention and cooperation needed for fitting and training.

Despite a large number of studies, the question of when to prescribe a myoelectric prosthesis for a pediatric patient remains one of the most controversial in the field of prosthetics today (Trost & Rowe, 1992). Research studies in this area up to the present time have been plagued by small sample sizes, a reliance on single-case studies, and inconsistent criteria for the determination of usage patterns. Further study, thus, is warranted in order to determine factors that could influence wearing patterns so
that clinicians will be able to prescribe for their pediatric patients prostheses that are both functional and beneficial.

Myoelectric Prescription Criteria

Atkins, Meier, and Muilenburg (1985) suggested that issues of cost effectiveness, with attention to function, appearance, maintenance and repair, are essential considerations in the prescription of a particular type of prosthesis. These authors noted that, as awareness and knowledge of electric prosthetic devices has grown, increasing numbers of physicians, third party payers, and patients have asked for prescription criteria specific to a myoelectric device. Despite the merits of myoelectric prostheses, researchers and clinicians have noted the high cost factors, both in initial fitting and in ongoing repairs (Millstein, Heger, & Hunter, 1986) that make the myoelectric an unreasonable prescription for all patients. Kruger and Fishman (1993) questioned whether or not a myoelectric, with its complexity and cost, is the preferred prescription for pediatric upper limb deficient children. These authors noted the voluminous, but primarily anecdotal, literature that exists currently and the lack of more definitive studies. Although clinicians may recognize the cosmetic value of the myoelectric prosthesis, they have admitted reservations about the prescription of such an expensive and functionally advanced prosthesis for occasional cosmetic
wear (Trost & Rowe, 1992). Hence, it will be useful to
determine factors which suggest that a myoelectric
prosthesis will be worn in a manner that is not only cost
effective, but also acceptable to the child.

The results of studies of adult amputee patients have
indicated that the acceptance of a myoelectric prosthesis is
dependent upon psychological, socioeconomic, and
occupational factors, as well as technical attributes of the
device and adequate training and follow-up care (Colburn,
1977; Herberts, Korner, Caine, & Wensby, 1980; Northmore-
Ball, Heger, & Hunter, 1980). Thus, when prescribing a
particular class of prosthesis, the clinician must consider,
in addition to the medical and physical history, a patient’s
psychological well-being, their ability to pay for and
maintain the device, and the type of activities for which
the device will be used.

It can be reasonably expected, then, that the
acceptance of a myoelectric among juvenile patients is
dependent upon similar factors. Michael (1990) emphasized
that the fundamental basis for designing a prosthesis for
pediatric patients is individualizing the device, taking
into account both the needs and the developmental readiness
of the child. In order for a clinician to decide whether or
not to prescribe the fitting of a myoelectric prosthesis for
a pediatric patient, certain factors must be considered that
could influence the wearing pattern that the child will develop.

Characteristics of the Patient

Medical History

Etiology of the amputation. Certainly, the physical factors of each child and their individual medical history will have an influence on the wearing pattern of a myoelectric prosthesis. Some studies have shown decreased wearing patterns with myoelectric prostheses when the children are congenital rather than acquired (the result of trauma or disease) amputees. Patterson, McMillan, and Rodriguez (1990), for instance, reported the acceptance and proficient use of a myoelectric by 14 of 18 patients, ages 2 to 17, but noted that three of the four who rejected their prosthesis were congenital amputees. Reasons cited for these patients’ rejection of the myoelectric prosthesis included refusal to wear, cosmetic use only, and/or wearing times in terms of parental demand. This suggests that some congenital amputees may develop greater functional ability without the use of a prosthesis or that the prosthesis in some way inhibits their ability to function. It is important to note that, in this study, the cosmetic function was cited as important by the child and/or the parents, despite the lack of functional use.

In a similar manner, Trost (1983) described a study in which 16 of 47 children, ages 6 to 16, rejected a
myoelectric prosthesis. Eleven of these sixteen children were congenital amputees, again suggesting a lack of functional and/or cosmetic need among these children. Scotland and Galway (1983) reviewed the wearing patterns of 131 children with upper limb deficiency, 116 of whom were congenital and 15 who were acquired amputees. Once again, although it is not clear as to which, the children who abandoned their prosthesis seemed to lack either a functional and/or cosmetic need to continue use.

Some researchers have suggested a significant enhancement of stump sensation in congenital amputees (Taylor, Yuschyshyn & McIvor, 1991). The results of their study measuring stump and normal limb sensation in addition to two-handed function revealed a statistically significant level of stump sensation, as compared with the contralateral limb. A correlation was found between sensory enhancement and improved stump function as well as between sensory enhancement and increased prosthetic rejection. These researchers suggested that sensory alterations may affect prosthetic use. That is, a congenital amputee may experience heightened physiological sensation in the residual limb which could enable them to use the myoelectric prosthesis more effectively. However, placing the prosthesis over the residual limb also may diminish that same heightened sensation which could be frustrating for the wearer and could, ultimately, lead to rejection.
Although researchers have suggested that congenital amputees are more likely than acquired amputees, to reject a myoelectric prosthesis, a clear relationship between etiology and myoelectric wearing patterns has not been established. Further study is warranted to determine other factors which may affect the wearing patterns of both congenital and acquired amputees.

Extent of amputation. Another medical factor that may influence a child's wearing pattern is the extent of the amputation, or whether the child has a unilateral (one limb) or bilateral (both limbs) loss. Trost (1983) described myoelectric prostheses with powered hands as unsuitable for bilateral amputees. Millstein, Heger, and Hunter (1982) also suggested bilateral amputations to be a contraindication for fitting with myoelectric prostheses because bilateral amputees require a high level of function from their prostheses. Furthermore, the tendency is for bilateral amputees to choose against the myoelectric prostheses due to the comparative weight, durability, reliability, and ease of operation of the body-powered, or cable-operated prostheses (Trost & Rowe, 1992) in comparison with the myoelectric. In one study (Millstein, Heger, & Hunter, 1982), all of the bilateral amputees indicated that they preferred to use a hook-type terminal device on both hands which provided more precision than the myoelectric hands. These authors recommended further evaluation of
wrist rotators and myoelectric hooks, rather than myoelectric hands, for bilateral amputee patients. Although the research up to the present time has indicated that bilateral amputees are unlikely to wear myoelectric prostheses, clinicians have observed that some bilateral amputee patients and their families insist on the child being fit with a myoelectric, despite only occasional wear. This anecdotal data suggests that other factors beyond successful functional use may influence the wearing pattern of a myoelectric prosthesis among pediatric patients.

**Length of residual limb.** The length of the residual (or remaining) limb also is a factor to consider when prescribing a myoelectric prosthetic device (Baron, Clarke, & Solomon, 1983). Some authors (Millstein, Heger, & Hunter, 1982) consider a long residual limb a contraindication for fitting with a myoelectric because of the resultant discrepancy between the lengths of the residual and "normal" limbs. Additional amputation may be necessary in order to achieve good cosmesis, but patients may be reluctant to undergo such surgery. A very short residual limb also is of concern as it may lack sufficient leverage for full control of the prosthesis (Trost & Rowe, 1992). Other researchers indicated that the length of the amputated limb is considered optimal when it is within the middle third of the contralateral forearm length; however, as long as the patient is willing to accept the cosmetic or functional
trade-offs, almost any length can be accommodated by a myoelectric prosthesis (Menkveld, Novotny, & Schwartz, 1987). As these researchers have noted, there are limitations to the use of a myoelectric by patients without optimal residual limb length, yet these patients still may request a myoelectric fitting. This suggests, once again, that factors beyond functional use are influencing the wearing patterns of upper limb deficient pediatric patients.

**Other medical complications.** One other factor in the medical history that could influence the wearing pattern of a myoelectric is the presence of other medical complications. Roeschlein and Domholdt (1989) found the presence of more than two complicating factors, such as visual handicaps, trauma to other limbs, or heart problems to be related negatively to successful upper extremity prosthetic use. Others noted difficulty fitting children with medical problems such as burn scars, skin grafts, bony overgrowths, or painful residual limbs (Setoguchi, 1989). Although it appears, up to the present time, that patients with additional medical complications are likely to reject a myoelectric prosthesis, factors beyond the medical complications also may influence wearing patterns and further study would be useful.

**Gender**

Beyond the significant medical issues, researchers have noted sex differences in the myoelectric wearing patterns of
juvenile amputees (Lyttle, Sweitzer, Steinke, Trefler, & Hobson, 1974). Menkveld, Novotny, and Schwartz (1987) described adolescent females as the optimal prosthetic users in their study, reporting the young women wore the myoelectric prostheses the greatest number of hours each day and had the fewest number of activities performed consistently without the prosthesis, which confirmed prior study (Lyttle, Sweitzer, Steinke, Trefler, & Hobson, 1974). Although these authors did not speculate as to why these female adolescent subjects wore the myoelectrics for extended periods, one could reason that the greater emphasis on appearance during adolescence, particularly among females, could be a contributing factor. Trost (1983) noted, among his subjects, proportionally more boys than girls rejected myoelectric prostheses. The common reasons for this rejection cited by the male subjects in this study included poor function, overall poor durability, and heavy weight. More recently, however, Kruger and Fishman (1993) reported that, in their study of 120 below-elbow child amputees, aged 3-18, the myoelectric was more popular with male subjects than a body-powered prosthesis or wearing no prosthesis at all. They noted also that nonprosthetic wear was more frequent among the female subjects; however, there were no identifiable differences between the sexes in the extent of prosthetic use. These research results offer no evidence of a clear relationship between gender and
myoelectric wearing patterns; hence, further study of gender and other factors that affect myoelectric wearing patterns may be useful in establishing or clarifying this relationship.

**Age**

The current age of the child also should be considered as a factor influencing wearing patterns. In the Kruger and Fishman study (1993) of 120 upper limb deficient children, a greater number of subjects in every age group preferred the myoelectric prostheses over body-powered prostheses and wearing no prosthesis. However, the researchers reported that the extent of myoelectric use was significantly less among preschool children. After following twenty children with myoelectric prostheses for one year, Menkveld, Novotny, and Schwartz (1987) reported that the middle childhood years showed the greatest variability in prosthetic choice and usage, and full-time use is unusual before adolescence. As a result of their findings, the authors concluded that older children primarily demand good appearance, though a passive hand may be an alternative to a myoelectric for this population. As there has been no clear relationship established between age and myoelectric wearing patterns, further research would be helpful in determining how wearing patterns change with age and how the importance of other factors affecting wearing patterns may change with age as well.
Self-Perception

One less apparent characteristic of a child that may influence the wearing pattern of a myoelectric prosthesis is the child’s self-perception. Harter (1987) suggested that the self-perception construct reflects a child’s cognitive appraisal of their own competence and adequacy in areas that are considered important both to the child and to society in general. Specifically, children develop their self-perception from their perceived adequacy or competence in areas such as physical appearance, academics, and athletics.

Physical appearance is one area of self-perception with which limb deficient children may struggle. An attitude of acceptance by the child of his or her appearance, as postulated by Harter, however, will influence positively the child’s overall self-perception. Further, Varni and Setoguchi (1991) stated that peer acceptance is at least partially a function of physical attractiveness. Thus, physical appearance, particularly in the case of upper-limb deficient children, could have significant importance. In a 1989 study of limb deficient children, Varni, Rubenfeld, Talbot, and Setoguchi noted the potential benefits of cosmetically pleasing prostheses in enhancing general self-perception.

Concern about one’s appearance usually increases with the approach of adolescence so that wearing patterns and the appearance of the prosthesis may become even more closely
related (Scotland & Galway, 1983). These researchers noted, in their study of the wearing patterns of 131 children fitted with upper-limb prostheses, that the greatest dropout rate occurred at the age of 13 years when adolescent amputees became more conscious of their appearance. Scotland and Galway reported that embarrassment about the appearance of a hook was an important factor in some adolescents’ decision to discontinue use.

Because physical appearance has been hypothesized to be an important component of peer social acceptance, as well as general self-perception, it is reasonable to conclude that a prosthetic device which improves the appearance of an upper-limb deficient child is more likely to be worn frequently than one which does not. Thus, upper-limb deficient children with a negative self-perception could be expected to wear a myoelectric prosthesis more frequently, purely for cosmetic use, whether or not they take advantage of the myoelectric’s functional capability.

**Perceived Social Support**

The term "perceived social support" refers to the cognitive appraisal by individuals that they are cared for and valued, that significant others are available to them if needed, and that they are satisfied with their interpersonal relationships (Heller, Swindle, & Dusenbury, 1986). Harter (1987) has theorized that, in addition to their feelings of adequacy and competence in areas deemed important, a child
also will base his or her self-perception on the support and regard they perceive from significant others in the environment, including parents, teachers, and peers. Varni and associates (1989) reported that higher perceived levels of classmate, parent, teacher, and friend social support were associated with a more positive self-perception among upper-limb deficient children. Cultural values about physical differences, however, may affect the social behavior of others toward those with visible physical handicaps.

Richardson (1970) described the emergence early in childhood of prejudice toward cosmetic differences. In this study, nonhandicapped children ranked children with cosmetic handicaps (left hand missing, facial disfigurement) as less liked than children with functional handicaps (need for crutches or wheelchair). The children with no physical handicaps were ranked as most liked. Other researchers have noted that, as early as the preschool years, children begin to devalue peers who are physically different (Sigelman & Begley, 1987). Even preschool-aged children tend to rate attractive peers as friendlier, smarter, and less likely to start fights than unattractive peers (Vaugh & Langlois, 1983). Thus, visibly handicapped children may experience a lack of social support as early as preschool. This potentially could have negative long term effects on the child’s perception of the social support they experience.
and, ultimately, their overall self-perception. Varni, Setoguchi, Rappaport, and Talbot (1991) suggested that low levels of classmate social support may increase the risk of depressive symptomatology and low self-esteem for children with upper-limb deficiencies.

Varni, Rubenfeld, Talbot, and Setoguchi (1989) described differential findings between classmate, parent, teacher, and friend social support in their study of twenty-seven 8 to 13 year old upper-limb deficient patients. Classmate social support was the most highly correlated with depressive symptomatology, although parent and teacher social support also were significantly correlated. The authors noted that the pattern of intercorrelations among the social support groups is consistent generally with, but higher than, the intercorrelations found in physically healthy children. They emphasized the need to measure various sources of social support for their potential differential influence rather than simply reporting a global index of social support.

Varni, Setoguchi, Rappaport, and Talbot (1991) examined perceived social support and its relationship to the adjustment factors of depressive symptomatology and trait anxiety among upper-limb deficient children. This study provided evidence of the potentially powerful effects of the social environment of the school setting, as indicated by the correlation between classmate and teacher social support.
with the adjustment factors. The authors noted that, as they had expected, best-friend relationships were more evident and influential among adolescents than among younger children.

One could expect, then, that children who perceive a low level of social support are likely to have a negative self-perception. Thus, the need for a cosmetic prosthesis with which to improve physical appearance and, additionally, foster peer acceptance, may result in a more frequent wearing pattern, likely with greater cosmetic than functional use. The children who perceive a greater level of social support could be expected to have a more positive self-perception and, thus, would be more likely to use the prosthesis functionally, on an as-needed basis.

Characteristics of the Family

Parental Expectations

Family psychosocial factors long have been recognized as important variables in coping with pediatric chronic disorders (Masters, Cerreto, & Mendelowitz, 1983; Varni, 1983; Wallander, Varni, Babani, Banis, & Wilcox, 1989). Characteristics of the family also are believed to be a factor affecting the wearing patterns of a myoelectric prosthesis. Rodgers and Scott (1980) suggested a direct relationship between a child's acceptance of a prosthesis and their parents' acceptance of the device. Sypniewski (1972) stated that the most important factor contributing to
a child’s acceptance of both a disability and a prosthesis is the attitude of and acceptance by that child’s family.

Many parents who were consistent in their expectations for wearing of a conventional prosthesis, however, have found it difficult to be consistent with myoelectric wear due to the weight and fragility of the device and their child’s intolerance of full-time wear (Brooks & Shaperman, 1965). The authors noted that the children who ultimately rejected a conventional prosthesis had parents who were inconsistent in their expectations that the child wear the prosthesis. The same results logically could be predicted for children with a myoelectric prosthesis as well. Though anecdotal data has been reported on parental expectations for a myoelectric prosthesis, and there is general clinical agreement that a relationship does exist, there have been few empirical studies on parent expectations and how they can affect the child’s use of a prosthesis.

Parental Desire for Cosmesis

Parents, much like their children, tend to focus more on the appearance of a prosthesis rather than its function. Ballance, Wilson, and Harder (1989) found that parents continued to prefer the myoelectric due to cosmetic advantages, even if their child did not use it spontaneously nor use it at home at all. These findings supported the results of other studies (Trost, 1983; Menkveld, Novotny, & Schwartz, 1987; Tervo & Leszcynski, 1983). Ballance,
Wilson, and Harder (1989) stated that cosmesis is a component of function and cannot be discounted but it does not reflect the potential of the myoelectric arm, especially when considering cost. Once again, there have been empirical studies that indicate parents' preference for a cosmetically pleasing prosthesis, but there is no indication in the literature of what effect this parental preference has, if any, on a child's myoelectric wearing pattern.

**Family Adaptation to Stress**

Finally, researchers have associated aspects of family functioning with general self-perception. Varni, Rubenfeld, Talbot, and Setoguchi (1989) found, in a study of 41 limb-deficient children, that a high level of family conflict, defined as the amount of openly expressed anger, aggression, and conflict among family members, was associated with a more negative self-perception. Higher family organization, or the degree of importance of clear organization and structure in planning family activities and responsibilities, was associated with positive self-perception. The authors concluded that the family is an important mediating factor in the child's adaptation to chronic illness.

As the family factors of organization and conflict can be associated with a child's self-perception, one can theorize that these factors indirectly affect a child's prosthetic wearing pattern as well. As discussed earlier, a
child with a more positive self-perception is less likely to wear the prosthesis to enhance his or her self-image and may use the prosthesis more functionally than cosmetically. A child with a negative self-perception, however, may rely on the cosmetic appearance of the device as a way of bolstering his or her self-image, wearing it more frequently, but for cosmetic reasons.

Purpose

The purpose of the present study was to determine how much of the variance in mean weekly wearing times of a myoelectric prosthesis can be attributed to the factors discussed, including the medical history, age, gender, self-perception, and perceived social support of the child, as well as the general functioning of the family. Key operational definitions are as follows:

1. Subjects are considered “acquired” amputees if they had an amputation after they were born, due to trauma or disease. Subjects are considered “congenital” amputees if they were missing the limb(s) at birth. The categorization of the etiology will be determined through a review of the medical history in the hospital chart.

2. The categorization of passive or active usage will be determined through the use of the Prosthetic Usage Diary (see Appendix A).
3. The categorization of extent of amputation (unilateral or bilateral) will be determined through a review of the medical history in the hospital chart.

4. The categorization of residual limb length will be identified through the use of limb length formulas and classifications in the Upper Limb Prosthetic Usage Questionnaire, using information from the medical chart (see Appendix B).

5. Subjects who are considered to have significant medical complications will have two or more of the following conditions: a visual handicap, trauma to other limbs, heart problems, bone or joint problems, phantom pain or sensation in the residual limb, burns scars, skin grafts, or bony overgrowths. Subjects who have less than two of these medical complications will be considered to have "none." The categorization of medical complications will be determined through a review of the medical history from the hospital chart.

6. The categorization of the age of the subject at the initial fitting of the first prosthesis as well as the initial fitting of the myoelectric prosthesis will be determined through a review of the medical history in the hospital chart.

7. Self-perception scores will be determined by the Global Self-Worth subscale score on the Self-Perception Profile for Children and the Self-Perception Profile for
Adolescents for subjects in the third through twelfth grades (Harter, 1988). For subjects in preschool through the second grade, scores on the perceived competence subscales from the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children (Harter & Pike, 1984) will be used.

8. Mean perceived social support scores will be determined by the four subscales of the Social Support Scale for Children and Adolescents (Harter, 1985) or the social acceptance subscales of the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children (Harter & Pike, 1984).

9. The degree of family conflict will be determined by a significant score on the Conflict subscale of the Family Environment Scale (Moos & Moos, 1981), which will be completed by the subject's parent.

10. The level of family organization will be determined by a significant score on the Organization subscale of the Family Environment Scale (Moos & Moos, 1981) as completed by the subject's parent.

Originally, the intent of this study was to include all categories of etiology (congenital or acquired), extent of amputation (unilateral or bilateral), the presence of medical complications (yes or no), the age of initial fitting of a prosthesis (two years old and younger or older than two years), and the age of fitting of a myoelectric
prosthesis (twelve years old and younger or thirteen and older). However, the final study sample revealed an insufficient number of subjects who had acquired or bilateral amputations, those who had additional medical complications, those who were older than two years of age at the fitting of their first prosthesis, and those who were older than thirteen at the fitting of a myoelectric prosthesis. In addition, the actual distribution of subjects, post data collection, across categorical variables necessitated a number of simplifications of hypotheses for the purposes of data analyses.

Hypotheses

A complete list of original hypotheses with relevant sample information on which the reformulated hypotheses were based are included in Appendix C. Therefore, the hypotheses to be tested include the following:

Hypothesis 1. Subjects who have an OPTIMAL residual limb length will have a significantly higher (p < .05) mean number of hours of myoelectric wear per week, as compared to subjects with NON-OPTIMAL (i.e. short, long or anomalous) limb length. A nonparametric analysis of mean rank differences utilizing a Mann-Whitney U test of difference will be performed.

Hypothesis 2. Subjects who fit the criteria for PASSIVE usage will have a significantly higher (p < .05) mean number of hours of myoelectric wear per week, as compared with
subjects who fit the criteria for ACTIVE usage. A non-parametric Mann-Whitney U test of difference will be performed.

**Hypothesis 3.** FEMALE subjects will have a significantly higher \((p < .05)\) mean number of hours of myoelectric wear per week, as compared with MALE subjects. A non-parametric Mann-Whitney U test of difference will be performed.

**Hypothesis 4a.** Subjects who are NON-USERS of the myoelectric will have significantly higher \((p < .05)\) self-perception scores than subjects who are USERS. A non-parametric Mann-Whitney U test of difference will be performed.

**Hypothesis 4b.** FEMALE subjects will have significantly lower \((p < .05)\) self-perception scores, as compared to MALE subjects. A non-parametric Mann-Whitney U test of difference will be performed.

**Hypothesis 5.** Subjects who are NON-USERS will have significantly higher \((p < .05)\) perceived social support scores than subjects who are USERS. A non-parametric Mann-Whitney U test of difference will be performed.

**Hypothesis 6a.** Subjects with a HIGH LEVEL OF FAMILY CONFLICT will have a significantly higher \((p < .05)\) mean number of hours of myoelectric wear per week, as compared to those subjects with a LOW LEVEL OF FAMILY CONFLICT. A non-
parametric Mann-Whitney U test of difference will be performed.

**Hypothesis 6b.** Subjects with a LOW LEVEL OF FAMILY ORGANIZATION will have a significantly higher \((p \leq .05)\) mean number of hours of myoelectric wear per week, as compared to those subjects with a HIGH LEVEL OF FAMILY ORGANIZATION. A non-parametric Mann-Whitney U test of difference will be performed.
CHAPTER II

METHOD

Subjects

Seventy-nine patients were contacted from the population of children with limb deficiencies who receive treatment at Texas Scottish Rite Hospital for Children in Dallas, Texas. Of those contacted, 17 were unavailable for participation, three declined to participate, five were ineligible, and 51 agreed to participate. Of the 51 patients who agreed to participate, 30 successfully completed the evaluation, while 21 returned incomplete data. Participating subjects were between the ages of four and 17, English-speaking, and fit with a myoelectric prosthesis at least two months earlier. Patients excluded from the study were non-English-speaking or had parents who were non-English speaking, those who were mentally retarded, and those who were emotionally or behaviorally disturbed.

The Texas Scottish Rite Hospital patient population overall is representative of the population at large. Prosthetic patients, however, tend to be Caucasian, though a sizeable percentage of Hispanic patients is seen as well. The Hospital is privately funded and provides all services free of charge. However, the quality of the Hospital's care
is well-known internationally, and families of all socioeconomic backgrounds seek help at the facility for its quality orthopedic services and caring professional staff, regardless of cost.

Of the 30 subjects who successfully completed the data, 16 (53.3%) were male and 14 (46.7%) were female. The age range was 4-17 years (M = 9.0, SD = 3.5). There were 11 (36.7% of N) subjects in the 4-7 year-old age group, three females and eight males. There were 15 (50% of N) subjects in the 8-12 year-old age groups, eight females and seven males. There were four (13.3%) subjects in the 13-17 year-old age group, three females and one male. Twenty-three (76.7%) of the subjects were Caucasian, five (16.7%) were Hispanic, and two (6.7%) were African-American. All of the subjects had congenital unilateral amputations, with no additional medical complications, and all of the subjects were initially fit with a prosthesis prior to age two. The age of fitting with a myoelectric prosthesis ranged from one to 13 years (M = 4.8, SD = 3.8).

Setting

The study was conducted in the Prosthetics Department at Texas Scottish Rite Hospital. The parent was placed in one room, while the examiner and subject were in an adjacent room. The examiner was available at all times to answer any questions from the subject or the parent.
Materials

Screening Measure

Child Behavior Checklist. The Child Behavior Checklist (Achenbach & Edelbrock, 1983) is an instrument widely used for evaluating the behavior problems of children. For the purposes of the present study, the Child Behavior Checklist was used to screen potential subjects for emotional disturbance and behavior problems. The Checklist consists of a list of behavioral problems and competencies, which are rated by parents or parent-surrogates. A three-point scale is used to rate each of 113 items, taking approximately 30 minutes to complete. Standard scores are provided for children ages 4-0 to 16-0. The Child Behavior Checklist is considered to be well-standardized, with adequate reliability and validity.

Primary Measures

Upper Limb Prosthetic Usage Questionnaire. The Upper Limb Prosthetic Usage Questionnaire (see Appendix B) was used to record the pertinent demographic data and medical history of each subject. The questionnaire was developed by the examiner and medical staff at Texas Scottish Rite Hospital for the purpose of this and other research studies.

Self-Perception Profile for Children. For subjects enrolled in the third to eighth grade, the construct of general self-perception was measured by the Self-Perception Profile for Children (SPPC) (Harter, 1985). On this
instrument, there is a general self-perception domain as well as five specific domains assessing self-perceived scholastic competence, social acceptance, physical appearance, athletic competence, and behavioral conduct. The general self-perception domain, or global self-worth, measures the extent to which one likes oneself as a person, is happy with the way one is leading one's life, and is generally happy with the way one is. Thus, it constitutes a global judgement of one's worth as a person. Scholastic and athletic competence domains directly assess self-perceived competence in these areas, while three other subscales measure various forms of self-perceived adequacy. These other three subscales do not necessarily, however, involve competence in the form of actual skills. The assumption underlying the construction of this scale is that an instrument providing an independent assessment of one's general self-perception, or global self-worth, as well as separate measures of one's perceived competency/adequacy in different domains will provide a more differentiated and informative picture than a single self-concept score.

The question format is designed to overcome the general tendency for socially desirable responses by using a devised "structured alternative" format. The child is asked to decide which of two sentences more accurately describes them, e.g. "Some kids find it hard to make friends BUT Other kids find it's pretty easy to make friends". Then the child
must indicate whether the chosen sentence is "really true" or "sort of true" for them. This format reduces the tendency toward socially desirable responses and provides the child with additional latitude to qualify their response. Subscale mean scores are computed and normative information given for comparisons on the basis of gender and grade placement. The Cronbach alpha internal consistency reliability of the global self-worth subscale is 0.80, which is similar to the other subscales' internal reliabilities, which have a range of 0.74 - 0.83.

Self-Perception Profile for Adolescents. For subjects enrolled in ninth to twelfth grade the construct of general self-perception was measured by the Self-Perception Profile for Adolescents (SPPA), (Harter, 1988) which is considered to be an upward extension of the Self-Perception Profile for Children (Harter, 1985) discussed earlier. As described for the children's measure, this instrument measures self-perceptions of Scholastic Competence, Athletic Competence, Physical Appearance, Social Acceptance, and Behavioral Conduct, as well as Global Self-Worth. In addition, the adolescent version includes three additional domains reflective of the concerns of adolescents: Job Competence, Close Friendship, and Romantic Appeal. The same assumption reflected in the children's version underlies the construction of this instrument, in that an instrument providing both a global self-worth measure as well as
separate measures of perceived competence or adequacy in different domains will provide a differentiated and informative picture. The content of the original six domains is maintained although the wording of some of the items was changed to make it more appropriate for adolescents. Also, the same question format of "structured alternative" items is used, as described in more detail earlier. Subscale mean scores can be computed for comparison with the scores and standard deviations of the normative group on the basis of gender and grade placement. The Cronbach alpha internal consistency reliability of the global self-worth subscale is 0.88, while the other subscale reliabilities range from 0.74 - 0.92.

Social Support Scale for Children. The construct of perceived social support was measured by the Social Support Scale for Children (SSSC), (Harter, 1985), for the subjects ages 8-18. This scale is designed to assess potential sources of social support and positive regard that the child may receive from significant others in his or her life. Using the "structured alternative" item format described earlier, the SSSC measures the degree to which the children perceive that significant others care for them as a person, like them the way they are, understand them, listen to them, and generally treat them as a person who matters. Thus, the central construct that the SSSC assesses is social support in the form of positive regard from others. The
relationships with significant others that can be evaluated with the SSSC include the following: parent(s), teacher(s), peer/classmate, and peer/close friend. The Parent Support scale assesses the extent to which the child perceives that his or her parents understand them, want to hear their problems, care about their feelings, treat them like a person who really matters, like them the way they are, and act like what their child does is important. The Teacher Support scale assesses the degree to which the child perceives that his or her teacher helps them if they are upset, helps them to do their very best, cares about them, is fair to them, and treats them as a person. The Classmate/Peer Support scale assesses the extent to which the child perceives that their classmates like them the way they are, are friendly, do not make fun of them, listen to what they say, and ask them to join in activities. The Close Friend/Peer Support scale is somewhat different from the other three subscales. The Parent, Teacher, and Classmate subscales all assume that these people exist in the child's life, while this subscale asks, through the same item format, whether or not the child has a close friend to whom they can complain about things that bother them, with whom they can spend time, and who really listens to what they say.

Each of the subscales has six items, which totals to 24 items for the entire SSSC. Subscale mean scores can be
computed for comparison with the norm group on the basis of grade placement and gender. The internal consistency reliabilities for the subscales range from 0.72 to 0.88.

The Pictorial Scale of Perceived Competence and Acceptance for Young Children. The Pictorial Scale of Perceived Competence and Acceptance for Young Children (Harter & Pike, 1984) was used with the youngest subjects, ages four to seven, for a measure of both self-perception and social acceptance. This scale originally was designed to be a downward revision of the Perceived Competence Scale for Children (Harter, 1982) which since has been revised into the Self-Perception Profile for Children (Harter, 1985). This scale also uses a domain-specific approach, with General Competence and Social Acceptance as the two major factors being measured. Four different subscales are included: Cognitive Competence, Physical Competence, Peer Acceptance, and Maternal Acceptance. Separate versions of the instrument are used for two age groupings: Preschool/Kindergarten and First/Second Grade. Each of the four subscales is comprised of six items, for a total of 24 items. The "structured alternative" format is maintained, although these items are accompanied by pictures with a target figure that is the same gender as the subject. The child is asked to choose which figure is more "like" them, and then to decide whether the figure is "really" like them or "sort of" like them. Although norms are not given for
this instrument, subscale means can be calculated for each subtest for each individual child.

**Family Environment Scale.** The Family Environment Scale (FES) was used to measure the construct of family functioning (Moos & Moos, 1981). The FES is composed of 90 true-false items scored on 10 subscales, which include cohesion, expressiveness, conflict, independence, achievement orientation, intellectual-cultural orientation, active-recreational orientation, moral-religious emphasis, organization, and control. The "real" form, which measures one's perception of one's current family environment, was used rather than the "ideal" form, which measures one's conceptions of the ideal family environment or the "expectations" form, which measures one's expectations about family settings (such as a couple's expectations about what their family will be like after the birth of their child). The FES was completed by one of the subject's parents. Test-retest reliabilities for the individual subscales range from 0.68 to 0.86 and profile stabilities from 0.70 to above 0.80. Internal consistency for the 10 subscales is reported by the authors to range from 0.61 to 0.78. Although the entire instrument was administered, the subscales for organization and conflict were of particular interest, as the results found in this study were for comparison to those of a prior study.
Procedure

Potential subjects were identified by systematic review of the medical charts of the Prosthetic Department at Texas Scottish Rite Hospital for Children. The charts were examined first to eliminate any myoelectric patients whose intellectual ability fell within the Mentally Retarded range, as evidenced by medical history, physicians' notes, and/or consultation reports. In addition, the chart was examined thoroughly in an effort to determine if the services of a translator had been required on previous visits, or if there were remarks describing the patient or his/her parents as non-English-speaking. Patients and their parents who did not speak or read English at an adequate level for comprehension of the assessment items were eliminated from the subject pool. Following the chart examination, a list of potential subjects, their addresses, phone numbers, and hospital chart numbers was assembled.

The parents of the children identified as possible study participants were contacted by phone by the primary researcher and screened with regard to the previously stated exclusion criteria. If they were determined eligible for participation, the parents were briefed on the process of participation and any questions that they had at that time were addressed. If the subject and his or her parents were willing to participate, an appointment time was scheduled with the researcher. If the patient and the family also
needed to meet with the Prosthetics Department staff for any reason (repairs, adjustments, etc.) an appointment was scheduled for the same time. All reasonable effort was made to limit the number of trips made to the Hospital. The day before their appointment, the parent was contacted again by phone as a reminder of their scheduled appointment.

Prior to the clinic appointment, the chart was examined in order to determine specific facts of the medical history. A data form was completed for each subject that included the following information: subject's age and sex, the category of the limb deficiency (unilateral or bilateral), the category of residual limb length (very short, optimal, very long), the age at which the child was first fit with any type of prosthetic device, and the age at which they were first fit with a myoelectric prosthesis. The subject also was classified, according to the history in the chart, as either congenital (having the deficiency at birth) or acquired (the limb loss occurred after the child was born). In addition, a checklist of the child's pertinent medical complications was completed, in order to determine the presence of two or more of these complications. This list included the following: visual handicap, trauma to other limbs, heart problems, bone or joint problems, phantom pain or sensation, burn scars, skin grafts, bony overgrowths, or a painful residual limb.
At the time of the clinic appointment, both the child and the parent were met by the primary researcher. Written consent was gained from the parent and verbal assent from the child. Consent from both parent and child was required for study participation. The FES and the Child Behavior Checklist were given to the parent and the parent was escorted to a private testing room to complete the instruments. The child was taken to a separate testing room to complete the self-perception and social support instruments. The instruments were administered by the primary researcher with the suggested standardized, age-appropriate instructions. Following the separate administration of the instruments to parent and child, the researcher met with the parent and child in order to complete the Upper Limb Prosthetic Usage Questionnaire. The parent and child were then presented with a Usage Diary to take home in order to record the number of hours that the patient wore the myoelectric prosthesis each day for a four week period. The instructions for the Usage Diary were reviewed and a self-addressed, stamped envelope was given to the family in which to mail back the diary once it was completed. The patient and parent then were given an opportunity to ask any final questions regarding the study.

The Child Behavior Checklist was scored first in order to eliminate subjects with behavioral or emotional problems. A score of 70 or above on any of the subscales of the
Checklist resulted in the removal of the subject from the pool, in order to prevent the presence of emotional or behavioral problems from confounding the results. Once these subjects were removed, the demographic and medical history data, as well as the scores from each individual item on all of the instruments, with the exception of the Prosthetic Usage Diary, were entered into the computer as data. Data recorded from the Prosthetic Usage Diary included categorization as an "active" or "passive" myoelectric user and the number of hours per week that the subject used the prosthesis. Each individual set of data was given a subject number to insure confidentiality outside the experimental setting. Following completion of the study, all information matching the subject's name and number was destroyed in order to protect the privacy of the research subjects.

Plan of Analysis

Preliminary analyses were conducted to examine the internal reliability of the various instruments and their subtests. Statistical analyses were then conducted to examine the differences in hours of myoelectric wear per four week period among the following subgroups as proposed in the hypotheses: residual limb length (optimal or non-optimal), usage (active or passive), gender, degree of family conflict, and degree of family organization. In addition, analyses were conducted to examine differences in
self-perception and perceived social support scores between users and non-users. Due to the small sample and subgroup sizes, the Mann-Whitney U test of difference, a non-parametric analog of t-test, was used for the purpose of statistical analysis for each hypothesis.
CHAPTER III

RESULTS

Preliminary Analyses

Cronbach's alphas on internal consistency were calculated on all subscales for each instrument (see Tables 1 and 2, Appendix D). Alphas for the self-perception subscales on the SPPC and SPPA were above or equal to .80, indicating internal consistency within each subscale. There is concern, however, about the Physical Competence subscale of the PIC, which is the version of the self-perception instrument used with the youngest subjects. The alpha suggests poor internal consistency, raising questions about whether these items are appropriate for use with this population. Item analysis reveals that the removal of one item raises the alpha value to .52, but this is still not within an acceptable range (i.e., at least .80). Therefore, interpretation of findings using this subscale must be conducted with great caution.

There also is concern about the alpha values for the perceived social support subscales, particularly those on the PIC. Although the alpha coefficient for the Maternal Acceptance subscale is marginally acceptable (.78), the value for the Peer Acceptance subscale is not (.51), again
raising questions about internal reliability of the subscales on this instrument as well as their use with this population. Item analysis on the Peer Acceptance subscale revealed only marginal improvement in the alpha value with the removal of certain items.

The alpha coefficients for the version of the perceived social support instrument for the subjects ages eight to seventeen were within an acceptable range (.82-.93), with the exception of the Parental Support subscale (.52). Subgrouping by gender and re-calculating the alphas raised the level of the coefficient for females (alpha = .69), but for males it dropped substantially (alpha = .13). Item analysis revealed that the alpha value for males could be raised by the deletion of one item (delete item #13; alpha = .52), but the coefficient is still below the level expected. The effects of heterogeneity may have affected the alpha coefficient here, as children within such a broad age range are likely to perceive their parents quite differently, and interpretations of the data from this subscale should be made with careful consideration of that issue.

Finally, alpha coefficients for the subscales of the FES were computed, resulting in a range of alpha values from .14 to .68 (see Table 2, Appendix D). Because of the low values, additional analyses were conducted in order to investigate within group heterogeneity that might be affecting alphas. As can be seen in Table 2 (Appendix D),
analyses conducted with subgrouping by age and by sex produced improvement in the alpha values for some of the subscales but these coefficients still suggest reason for caution in interpretation of the FES data.

**Study Hypotheses**

**Hypothesis 1.** Subjects who have an OPTIMAL residual limb length will have a significantly higher ($p < .05$) mean number of hours of myoelectric wear per week, as compared to subjects with NON-OPTIMAL limb length.

Mann-Whitney U analyses indicated a significant difference ($MW-U = 2.09, p < .04$) between optimal and non-optimal limb length on Week One mean hours worn (mean rank 17.6 vs. 11.4, respectively) with subjects of optimal limb length wearing the myoelectric 1.64 hours vs. .36 hours during Week One.

Mann-Whitney U analyses for Weeks Two through Four indicated similar results, although with only marginal significance (see Table 3, Appendix D). However, the pattern of results was the same, in that subjects with optimal limb length wore the myoelectric prosthesis five to six times as long as those with non-optimal limb length.

Of note is the large difference in variability in mean hours worn across the four weeks between the two groups with optimal wearers showing consistently larger standard deviations across all four weeks. Such heterogeneity strongly supports the use of non-parametric analyses and
denotes a larger range in the hours of weekly wear by the optimal group. Additionally, one individual in the group of subjects with optimal limb length had sufficiently higher mean wearing times across all four weeks to warrant consideration as an "outlier" in the data set. However, the small sample size and lack of evidence in the literature precludes any judgement as to the non-representativeness of this individual. Therefore, the data from this subject were included in the analysis as representative of individuals with higher wearing times.

Hypothesis 2. Subjects who fit the criteria for PASSIVE usage will have a significantly higher (p ≤ .05) mean number of hours of myoelectric wear per week, as compared with subjects who fit the criteria for ACTIVE usage.

Mann-Whitney analyses revealed no significant difference between active and passive users in mean number of hours of myoelectric wear per week. A pattern in the data, however, indicated that active users tended to wear the prosthesis nearly twice as often as passive users (see Table 4, Appendix D).

Hypothesis 3. FEMALE subjects will have a significantly higher (p ≤ .05) mean number of hours of myoelectric wear per week, as compared with MALE subjects.

Mann-Whitney U analyses indicated no significant differences between female and male subjects in mean hours
of weekly wear across a four week period. However, a consistent pattern emerged, with male subjects wearing the myoelectric about twice as long as female subjects each week (see Table 5, Appendix D).

**Hypothesis 4a.** Subjects who are NON-USERS of the myoelectric will have significantly higher \((p < .05)\) self-perception scores than subjects who are USERS.

Mann-Whitney U analyses indicated no significant differences between users and non-users across all three age groups and across all three versions of the self-perception instrument.

**Hypothesis 4b.** FEMALE subjects will have significantly lower \((p < .05)\) self-perception scores, as compared to MALE subjects.

Mann-Whitney U analyses indicated no significant differences between males and females across all three age groups and across all three versions of the same instrument. However, a trend in the data for the eight to twelve year old group indicated that males scored slightly higher on all subscales, including the global self-perception subscale, with the exception of the behavioral subscale (see Table 6, Appendix D).

**Hypothesis 5.** Subjects who are NON-USERS will have significantly higher \((p < .05)\) perceived social support scores than subjects who are USERS.
Mann-Whitney U analyses indicated no significant differences between users and non-users across all three age groups and two versions of the same instrument. However, a trend in the data from the combined eight to eighteen year old age group suggested that users score consistently higher on all subscales of the perceived social support instrument (see Table 7, Appendix D).

**Hypothesis 6a.** Subjects with a HIGH LEVEL OF FAMILY CONFLICT will have a significantly higher ($p < .05$) mean number of hours of myoelectric wear per week, as compared to those subjects with a LOW LEVEL OF FAMILY CONFLICT.

Subjects were divided into "high" and "low" groups based on comparison of their subscale score with the mean subscale score from the FES normative population. Those subjects with scores below or equal to the subscale mean score were included in the "low" group, while those with scores above the mean were included in the "high" group.

Mann-Whitney analyses indicated no significant differences between subjects with a high level of family conflict and those with a low level of family conflict in mean hours of weekly wear across a four week period (see Table 8, Appendix D). In consideration of the low alpha coefficients found for this subscale, as discussed earlier, additional Mann-Whitney analyses were conducted using data from the younger subjects only (i.e., the subgroup with the highest alpha coefficients) but no significant differences
were found (see Table 9, Appendix D). However, the data for four to twelve year old subjects did reveal a trend toward a higher mean number of hours of myoelectric wear for subjects with a high level of family conflict. These subjects tended to wear the myoelectric nearly twice as long as those with a low level of family conflict (see Table 9, Appendix D).

These subgroup comparisons indicate that measurement error from within group heterogeneity may be as problematical as low power in assessing between group differences for this hypothesis. Thus, any comparisons between these two groups on level of family conflict must be made with caution, due to the low internal reliability of this scale within this population, as indicated by the preliminary analyses, particularly in reference to the adolescent subjects.

**Hypothesis 6b.** Subjects with a LOW LEVEL OF FAMILY ORGANIZATION will have a significantly higher ($p \leq .05$) mean number of hours of myoelectric wear per week, as compared to those subjects with a HIGH LEVEL OF FAMILY ORGANIZATION.

As with the analysis completed on the previous hypothesis, subjects were divided into "high" and "low" groups based on comparison of their subscale score with the mean subscale score from the FES normative population. Those subjects with scores below or equal to the subscale mean score were included in the "low" group, while those
with scores above the mean were included in the "high" group.

Mann-Whitney analyses indicated no significant differences between subjects with a high level of family organization and those with a low level of family organization in mean hours of weekly wear across a four week period. An interesting pattern in the data was observed, however, as subjects with a low level of family organization consistently wore the prosthesis longer than those with a high level of family organization (see Table 10, Appendix D). As with the previous analyses concerning family conflict, subgroup alphas (see Table 2, Appendix D) clearly indicate within group heterogeneity for the family organization measure as well. Thus the same caution and limitations apply to analyses of group differences across family organization. Any interpretations of this data must be made with strong consideration of the low internal reliability of this instrument with this population.
Certainly, the current study has a number of limitations. First, the total sample size and resulting subgroup sizes upon which the analyses were conducted, were small, which, as noted in the initial literature review, is typical of the previous research conducted in this area (Kruger & Fishman, 1993). As a result, the power of the analyses is low, making it difficult to detect statistically significant effects. In addition, generalizations from the trends in the data can be made only with great caution. Although information from the study may be clinically interesting and relevant, these limitations must be kept in mind.

Another significant area of concern is that of the internal reliability of the instruments used. In regard to the FES, which was used to examine levels of family functioning, the alpha values were extremely low, particularly for an established instrument. Although subgrouping, according to age and gender, improved the alpha values somewhat, further item analysis indicated that deleting certain items raised the alpha values even more. These results suggest that there is sufficient variability
in responses to the deleted items to warrant serious consideration as to the validity of those items for this population. Thus, attention to the validity of the FES for this population needs to be re-addressed in future studies. It simply may be the case that a modified FES item set is more appropriate for this particular population. However, due to the small sample size of the present study, it is difficult to determine whether these problems with the FES truly are related to this unique group of children and their families or are simply an artifact of this data set.

Additionally, there were low alpha values found in two other instrument subscales. One, the self-perception subscale for Physical Competence on the PIC, used for children ages four to seven, may be inappropriate for this population due to the variability in physical capabilities of children, particularly amputees, at this age. The items ask the child to rate themselves on skills such as tree climbing, skipping, shoe tying, and swinging. A wide variation in answers can be anticipated from children in this population, depending on the degree of adaptation to their amputation through the use of a prosthesis and exposure to physical and occupational therapy. More internal consistency may be found if the scale were limited to items that did not involve use of the upper extremities and, thus, a modified item set may be more useful in future studies.
The other subscale of concern is the Parental Support subscale of the perceived social support instrument. As mentioned earlier, the wide age range (8-17-year-olds) of the subjects who completed this instrument is likely to have resulted in a large degree of variability in the responses. In addition, further analyses indicated a large degree of variability in responses from male vs. female subjects. As a result, the heterogeneity of the population and the variability of responses to the items of this particular subscale demand cautious interpretation. It is only this particular subscale of this instrument, however, that requires such interpretation, as the alpha values for the other subscales are within the desired range.

Despite these limitations, certain patterns in the data are worth further discussion. The one area in which the findings were statistically significant was in the comparison of optimal and non-optimal residual limb lengths on wearing time per week. The fact that statistical significance was found with even a small sample suggests that this is an issue of importance to consider when prescribing a myoelectric for a pediatric patient. Previous research findings indicated that fitting a child with a myoelectric was possible despite the length of the residual limb, as long as the child was willing to compromise on either cosmesis or effective use (Menkveld, Novotny, & Schwartz, 1987). However, the findings here suggest that
children with optimal residual limb length wear the myoelectric for far greater number of hours than those with non-optimal residual limb length. Thus, residual limb length should be one of the deciding factors in the prescription of a prosthesis, particularly with consideration to cost effectiveness. Although a child with non-optimal limb length may be willing to sacrifice some cosmetic appeal or even function, certainly the amount of time they actually will use the prosthesis is the more important issue to consider. Based on these findings, clinicians would be wise to use residual limb length as a screening criteria, at the very least, for whether or not to prescribe a myoelectric prosthesis for a particular child.

Continuing in terms of cost effectiveness, an interesting pattern in the data also emerged regarding usage patterns and amount of wearing time. The children in the study who wore the prosthesis and used it actively tended to use it more frequently, in comparison with those who wore it passively, or for cosmetic purposes. This is to say that the active users wore it in a manner that implemented the functional capabilities and they wore it for time periods that appeared reasonable, given the expense of the prosthesis. However, there were significantly fewer of these children, as eighteen of the thirty subjects in this study rejected the myoelectric prosthesis completely. An area for further research, then, would be why some children
completely reject the myoelectric, while others use it for all its capabilities. In these days of skyrocketing medical costs, a driving rationale behind studies such as this one is the issue of cost effectiveness. An issue with which future researchers must grapple, then, is whether they are concerned with the wearing of the myoelectric in any fashion or, more specifically, with the usage of the myoelectric in the manner for which it was designed. Although this study does not resolve questions about determining "appropriate" use of the myoelectric, it gives strong implications to consider in clinical settings.

Another pattern in the data worth examining is that the males in this study tended to wear the myoelectric twice as long as the females. Previous researchers have characterized adolescent females as the optimal myoelectric users (e.g. Menkveld, Novotny, & Schwartz, 1987) and others have noted the high rejection rate by male amputees (e.g. Trost, 1983). However, the results of the multi-center study by Kruger and Fishman (1993) indicated that the myoelectric was more popular with males, ages 3 to 18, although the extent of wearing time was not examined. The higher mean hours of wear displayed by males in the present study would seem to support the findings of Kruger and Fishman. The relationship between gender and myoelectric wear, thus, has not been clearly established and deserves further examination.
The issue of self-perception and its impact on wearing patterns merits further study, despite the lack of significant results found here. The small sample size prohibited the statistical analyses of relationships between self-perception and the other variables of gender, usage, and wearing times which are of great clinical interest. The only pattern in the data of interest is that females had lower self-perception subscale scores overall except in the area of behavior. One could speculate that a missing limb has a dramatic effect on a female child's overall self-perception. However, this is simply not borne out by the data here, nor have there been previous studies that establish this idea. It is of interest, though, that the female subjects in this study responded in this manner and further study with a larger sample size could prove to be clinically useful.

Of initial interest in this study was the relationship between usage, amount of wearing time, and perceived social support, with the expectation that those children who perceived the least amount of social support would wear the myoelectric passively, perhaps to improve their appearance, and for extended periods of time. Unfortunately, due to sample size, the interrelationships among these variables could not be examined. However, a pattern in the data that did emerge was that users of the myoelectric, whether active or passive usage, perceived greater levels of social support
than non-users. Previous findings have linked low levels of perceived social support with depressive symptomatology (Varni, Setoguchi, Rappaport, & Talbot, 1991) in this population so the implications for the users of the myoelectric in this study can be considered positive. However, continued study and, of course, larger sample sizes, will be essential to examine the interrelationships of all these variables.

Likely as a result of clinical observation, many researchers have attempted to study the relationship between family factors and the successful prescription of a myoelectric prosthesis (Ballance, Wilson, & Harder, 1989; Brooks & Shaperman, 1965; Menkveld, Novotny, & Schwartz, 1987). Varni, Rubenfeld, Talbot, and Setoguchi (1989) examined the relationship between family factors and an amputee's self-perception. The present study attempted to build on earlier findings by examining the relationship between family factors, usage, and wearing times by hypothesizing that those children with negative family factors would likely have a negative self-perception. This could result in a need for cosmetic enhancement of their appearance to bolster their self-perception which could lead to wearing the myoelectric passively for extended periods. As with the previous hypotheses, an examination of the interactions between these variables could not be conducted due to the small sample and subgroup sizes. In addition,
there were significant concerns about the internal reliability of the instrument used to measure family characteristics. As a result, even the most general patterns in the data must be interpreted with great caution. One interesting finding was that those subjects with a high level of conflict in their family wore the prosthesis for longer periods, as did those with a low level of organization. This would support the original ideas proposed in this study in regard to these variables but further study must be done, with careful attention to the instruments used in order to establish conclusions of statistical significance and clinical usefulness.

Despite the lack of statistical significance for the majority of the findings in this study, none of the patterns found in the data here are contradictory to findings from previous research. As a result, this study is most profitably thought of as a first exploratory study to examine myoelectric wearing patterns for pediatric patients. Inherent in the status of being an exploratory study then, are the trials of uncovering sample characteristics useful to future researchers, including the prevalence of congenital and unilateral amputees among pediatric patients. Although it is possible that the sample in this study is atypical, it is more likely that multi-site studies are required to establish adequate sampling across categories such as etiology and extent of amputation. In addition, the
results of this study draw attention to a need for the careful selection of measures that are appropriate for this population. Despite the usefulness of age-specific measures in many instances, the assumption cannot be made that the meaning is the same at each age level. On the other hand, a measure that covers a broad range of ages may lend itself to problems associated with heterogeneity and the variability in responses may limit the usefulness of such a measure. Thus, the major contribution of this study involves guidelines for methodology, particularly as related to sample size and characteristics, that gives future researchers an initial assessment of the problems they face in attempting to gain a greater understanding of the pediatric amputee.
Upper Limb Prosthetic Usage Diary

Children who wear arm prostheses may differ in how often and for what purposes they use their prosthesis. Some may wear their prosthesis all day long for many purposes, and some may prefer to use no prosthesis at all. Others may choose to wear their prosthesis only on certain occasions for a very specific reason. Because we want to understand how often and for what activities children may use their prostheses, we are asking for your help to describe the individual way your child uses his or her prosthesis.

1. Please indicate on which days of the next four weeks your child wears his or her prosthesis, and indicate how many hours he or she wore it on each of those days. If the prosthesis was never worn, please check that category. If the prosthesis was worn for specific activities only, please indicate the activities for which the child wore the prosthesis and circle the number of hours worn on that day of the weekly chart.

a. WEEK ONE: My child wore his or her prosthesis on these days, for this many hours per day (check the day and circle the number of hours):

- Monday: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, over 12
- Tuesday: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, over 12
- Wednesday: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, over 12
- Thursday: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, over 12
- Friday: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, over 12
- Saturday: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, over 12
- Sunday: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, over 12

   My child did not wear the prosthesis.

My child did not wear the prosthesis regularly, but wore it for the following activities (Examples: sports, visiting friends, school photographs, family gatherings, church, arts & crafts): *Please circle the number of hours worn for these activities on weekly chart above.

b. WEEK TWO: My child wore his or her prosthesis on these days, for this many hours per day (check the day and circle the number of hours):
C. WEEK THREE: My child wore his or her prosthesis on these days, for this many hours per day (check the day and circle the number of hours):

Monday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12
Tuesday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12
Wednesday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12
Thursday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12
Friday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12
Saturday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12
Sunday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12

My child did not wear the prosthesis.

My child did not wear the prosthesis regularly, but wore it for the following activities (Examples: sports, visiting friends, school photographs, family gatherings, church, arts & crafts): *Please circle the number of hours worn for these activities on the weekly chart above.

d. WEEK FOUR: My child wore his or her prosthesis on these days, for this many hours per day (check the day and circle the number of hours):

Monday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12
Tuesday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12
Wednesday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12
Thursday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12
Friday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12
Saturday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12
Sunday: 0,1,2,3,4,5,6,7,8,9,10,11,12, over 12

My child did not wear the prosthesis.
My child did not wear the prosthesis regularly, but wore it for the following activities (Examples: sports, visiting friends, school photographs, family gatherings, church, arts & crafts): *Please circle the number of hours worn for these activities on weekly chart above.

2. The hand (or hook) part of the prosthesis may be used by the child in many ways. The hand may be opened and closed to allow it to work as a gripper or holder. It also can be used without opening and closing, for example, to push objects around, balance a cafeteria tray, or hold down a piece of paper while the other hand writes. Some children may open and close the hand frequently in order to grip and hold, others may never open or close it, and still others will only open and close the device for specific activities.

Please help us understand the unique way your child uses his or her prosthesis.

When wearing his/her prosthesis, my child uses the hand (or hook) mostly as:

a gripper, pincher, or holder (meaning the hand is frequently opened and closed to grasp objects).

a pusher, balancer, or as a way to press things down (meaning the hand is seldom opened).

a cosmetic hand (meaning the hand is never opened).

my child opens and closes the hand for the following activities:

THANK YOU FOR THIS INFORMATION. PLEASE PLACE IN THE STAMPED, ADDRESSED ENVELOPE YOU WERE GIVEN AND MAIL IT BACK TO US AS SOON AS YOU CAN.
APPENDIX B

UPPER LIMB PROSTHETIC USAGE QUESTIONNAIRE
Upper Limb Prosthetic Usage Questionnaire

Date: ________________________________
Pt. Name: ________________________________ TSRH N: ________________
D.O.B.: ________________________________
Height: ________________________________ Weight: ________________

M _____ F _____
Diagnosis: ________________________________

Date of Amp (d.o.b. if congenital): ________________________________

L- R Bilateral

Measurements: L____ Length_____________ Class.__________
R____ Length_____________ Class.__________

Length Formulas:

Unilat. AE: % = RL Length X 100
Sound Arm Length

Bilater. AE: % = RL Length X 100
Height (inches) X 0.19

Unilat. BE: % = RL Length X 100
Sound Forearm Length

Bilater. BE: % = RL Length X 100
Height (inches) X 0.14

Length Classifications

Upper Arm:
0-30% = Shoulder Disarticulation (SD),
numeral Neck (HN) 30-50% = Short Above Elbow (Short AE)
50-90% = Standard Above Elbow (Standard AE)
90-100% = Elbow Disarticulation (ED)

Forearm:
0-35% = Very Short Below Elbow (Very Short BE)
35-55% = Short Below Elbow (Short BE)
55-100% = Long Below Elbow (Long BE)
100% = Wrist Disarticulation (WD)
100% + = Partial Hand levels (look for specific diagnosis in chart)

(Answers from chart if available, interview if not)
1. At what age (give date if known), did your child receive his/her first prosthesis? ________________

2. What kind of prosthesis was your child's first one?
   a. Passive
   b. CAPP Device
   c. Voluntary opening hook
   d. Voluntary closing hook
   e. Sports
   f. Cable-operated hand

   Myoelectric
   g. 1-site "cookie crusher"
   h. 2-site
   i. Other ________________

   Elbow Type (if above-elbow)
   j. Outside Locking Elbow
   k. Positive Locking Elbow
   l. Friction Elbow
   m. Myo. Elbow
   n. Switch-Operated Elbow
   o. Passive (No joint)
   p. Other:

3. With what prosthesis has your child most recently been fitted?
   a. Passive
   b. CAPP Device
   c. Voluntary Opening Hook
   d. Voluntary Closing Hook
   e. Sports
   f. Cable Operated Hand

   Myoelectric:
   g. 1-Site
   h. 2-Site
   i. Other: ________________
   j. No prosthesis

4. When was this prosthesis fit?
   a. Two months ago or less (please give date of fitting):
   b. Between two months and one year ago
   c. More than one year ago (estimate the arm's age):
5. Does your child have any of the following medical complications (Check as many as apply):

a. visual handicap
b. trauma to other limbs
c. heart problems
d. bone or joint problems
e. phantom pain or sensation in the residual limb(s)
f. burn scars on the residual limb(s)
g. skin grafts on the residual limb(s)
h. bony overgrowths on the residual limb(s)
i. painful residual limb(s)

6. This Prosthetic Usage Questionnaire was completed by (Check as many as apply):

a. Prosthetics Dept staff member (please initial here—

b. Shannon Glenn
c. Patient’s mother
d. Patient’s father
e. Patient
APPENDIX C

ORIGINAL HYPOTHESES
Original Hypotheses

ORIGINAL HYPOTHESIS 1a: Subjects who are ACQUIRED amputees that fit the criteria for PASSIVE usage will have a significantly higher ($p \leq .05$) mean number of hours of myoelectric wear per week, as compared to ACQUIRED amputees who fit the criteria for ACTIVE usage, and CONGENITAL amputees who fit the criteria for ACTIVE or PASSIVE usage. A 2x2 analysis of variance will be performed with etiology (congenital or acquired) and usage (active or passive) as the main effects and mean number of hours of myoelectric wear per week as the dependent variable.

This hypothesis was dropped due to characteristics of the sample as all subjects who completed the study ($n = 30$) were congenital amputees.

ORIGINAL HYPOTHESIS 1b: Subjects who are UNILATERAL amputees that fit the criteria for PASSIVE usage will have a significantly higher ($p \leq .05$) mean number of hours of myoelectric wear per week, as compared to UNILATERAL amputees who fit the criteria for ACTIVE usage, and BILATERAL amputees who fit the criteria for ACTIVE or PASSIVE usage. A 2x2 analysis of variance will be performed, with extent of the amputation (unilateral or bilateral) and usage (active or passive) as the main effects and the mean number of hours of myoelectric wear per week as the dependent variable.

This hypothesis was dropped due to characteristics of the sample as all subjects who completed the study ($n = 30$) were unilateral amputees.

ORIGINAL HYPOTHESIS 1c: Subjects who have an OPTIMAL residual limb length and fit the criteria for ACTIVE use of the prosthesis will have a significantly higher ($p \leq .05$) mean number of hours of myoelectric wear per week, as compared to subjects with OPTIMAL limb length who fit the criteria for PASSIVE usage, subjects with SHORT residual limb length who fit the criteria for ACTIVE or PASSIVE usage, subjects with LONG residual limb length who fit the criteria for ACTIVE or PASSIVE usage, and subjects with ANOMALOUS residual limb length who fit the criteria for ACTIVE or PASSIVE usage. A 2x4 analysis of variance will be performed, with residual limb length (short, optimal, long, or anomalous) and usage (active or passive) as the main effects and mean number of hours of myoelectric wear per week as the dependent variables.
Due to small sample size ($n = 30$), a 2x4 analysis of variance of active/passive usage vs. short/optimal/long/anomalous limb length was simplified to two separate Mann-Whitney tests of difference, i.e., active vs. passive usage and optimal vs. non-optimal limb length (short, long, or anomalous), on mean weekly hours of wear. Sample sizes were active ($n = 8$), passive ($n = 4$), optimal ($n = 20$), and non-optimal ($n = 10$). Thus, the original hypothesis was re-formulated to the following:

Re-formulated Hypothesis 1: Subjects who have an OPTIMAL residual limb length will have a significantly higher ($p \leq .05$) mean number of hours of myoelectric wear per week, as compared to subjects with NON-OPTIMAL limb length. A nonparametric analysis of mean rank differences vis-à-vis a Mann-Whitney U test of difference will be performed.

Re-formulated Hypothesis 2: Subjects who fit the criteria for PASSIVE use will have a significantly higher ($p \leq .05$) mean number of hours of myoelectric wear per week, as compared with subjects who fit the criteria for ACTIVE use. A non-parametric Mann-Whitney U test of difference will be performed.

ORIGINAL HYPOTHESIS 1d: Subjects with NO SIGNIFICANT MEDICAL COMPLICATIONS that fit the criteria for ACTIVE usage will have a significantly higher ($p \leq .05$) mean number of hours of myoelectric wear per week, as compared to those subjects with NO SIGNIFICANT MEDICAL COMPLICATIONS who fit the criteria for PASSIVE usage, and subjects WITH SIGNIFICANT MEDICAL COMPLICATIONS who fit the criteria for either ACTIVE or PASSIVE usage. A 2x2 analysis of variance will be performed, with the presence of medical complications (yes or no) and usage (active or passive) as the main effects and the mean number of hours of myoelectric wear per week as the dependent variable.

This hypothesis was dropped due to characteristics of the sample as all subjects who completed the study ($n = 30$) had no significant medical complications.

ORIGINAL HYPOTHESIS 1e: Subjects who were TWO YEARS OLD OR YOUNGER AT THE TIME OF THE INITIAL FITTING OF A PROSTHESIS and who fit the criteria for ACTIVE usage will have a significantly higher ($p \leq .05$) mean number of hours of myoelectric wear per week, as compared to those subjects who were TWO YEARS OLD OR YOUNGER AT THE TIME OF THE INITIAL FITTING OF A PROSTHESIS and who fit the criteria for PASSIVE usage and to those who were THREE YEARS AND OLDER AT THE TIME OF THE INITIAL FITTING and who fit the criteria for ACTIVE or PASSIVE usage. A 2x2 analysis of variance will be
performed, with age at fitting of initial prosthesis (two years and under OR three years and older) and usage (active or passive) as main effects and the mean number of hours of myoelectric wear per week as the dependent variable.

This hypothesis was dropped due to characteristics of the sample as all subjects who completed the study (n = 30) were two years old or younger at the time of the fitting of their first prosthesis.

**ORIGINAL HYPOTHESIS 1f:** Subjects who were THIRTEEN YEARS AND OVER AT THE INITIAL FITTING OF A MYOELECTRIC PROSTHESIS, and who fit the criteria for PASSIVE usage will have a significantly higher (p ≤ .05) mean number of hours of myoelectric wear per week, as compared to those subjects who were THIRTEEN YEARS AND OVER and fit the criteria for ACTIVE usage, and those subjects who were TWELVE YEARS AND UNDER and fit the criteria for either ACTIVE or PASSIVE usage. A 2x2 analysis of variance will be performed, with the age of the fitting of a myoelectric (twelve and under OR thirteen and over) and usage (active or passive) as the main effects and the mean number of hours of myoelectric wear per week as the dependent variable.

This hypothesis was dropped due to characteristics of the sample as only one subject of the entire sample (n = 30) was thirteen years or older at the initial fitting of a myoelectric prosthesis.

**HYPOTHESIS 2:** FEMALE subjects who fit the criteria for PASSIVE usage will have a significantly higher (p ≤ .05) mean number of hours of myoelectric wear per week, as compared with FEMALES who fit the criteria for ACTIVE usage, and MALES who fit the criteria for either ACTIVE or PASSIVE usage. A 2x2 analysis of variance will be performed with gender and usage (active or passive) as the main effects and mean number of hours of myoelectric wear per week as the dependent variable.

This hypothesis was modified due to the small sample size (n = 30) and small subgroup sizes (i.e. female passive users = 1, female active users = 3, male passive users = 3, male active users = 5) on which statistical analyses could not be performed. Thus, the original hypothesis was re-formulated to the following:

Re-formulated Hypothesis 3: FEMALE subjects will have a significantly higher (p ≤ .05) mean number of hours of myoelectric wear per week, as compared with MALE subjects. A non-parametric Mann-Whitney U test of difference will be performed.
ORIGINAL HYPOTHESIS 3: Subjects who are THIRTEEN YEARS OF AGE AND OLDER and fit the criteria for PASSIVE usage will have a significantly higher (p ≤ .05) mean number of hours of myoelectric wear per week, as compared to subjects who are THIRTEEN YEARS OF AGE AND OLDER thirteen years of age and over and fit the criteria for ACTIVE usage, and subjects who are TWELVE YEARS OLD AND YOUNGER and fit the criteria for ACTIVE or PASSIVE usage. A 2x2 analysis of variance will be performed, with age (twelve and younger OR thirteen and older) and usage (active or passive) as the main effects and mean number of hours of myoelectric wear per week as the dependent variable.

This hypothesis was dropped due to low subgroup sizes, as only four subjects were thirteen and older, and three of these four subjects were non-users of the myoelectric, thus, having no mean weekly wearing times.

ORIGINAL HYPOTHESIS 4a: Subjects who are CONGENITAL amputees and who fit the criteria for PASSIVE usage will have significantly lower (p ≤ .05) self-perception scores than subjects who are CONGENITAL amputees and fit the criteria for ACTIVE usage and those subjects who are ACQUIRED amputees who fit the criteria for ACTIVE or PASSIVE usage. A 2x2 analysis of variance will be performed, with etiology (congenital or acquired) and usage (active or passive) as the main effects and self-perception scores as the dependent variable.

This hypothesis was revised due to characteristics of the sample as all subjects who completed the study (n = 30) were congenital amputees. A re-formulated hypothesis to examine usage patterns (active or passive) and self-perception scores was considered. However, the number of subjects who actually used the myoelectric was quite small (n = 12) even before the categorization of active and passive usage patterns. In addition, the self-perception instrument (PIC, SPPC, and SPPA) used required a division of the subjects into three age groups. This division of subjects by age along with the division of subjects by usage resulted in subgroups too small to analyze. The hypothesis was re-formulated once again, to examine the self-perception scores of users (active and passive) vs. non-users:

Re-formulated Hypothesis 4a: Subjects who are NON-USERS of the myoelectric will have significantly higher (p ≤ .05) self-perception scores than subjects who are USERS. A non-parametric Mann-Whitney U test of difference will be performed.
ORIGINAL HYPOTHESIS 4b: FEMALE subjects who fit the criteria for PASSIVE usage will have significantly lower (p < .05) self-perception scores, as compared to FEMALE subjects who fit the criteria for ACTIVE usage, and MALE subjects who fit the criteria for either ACTIVE or PASSIVE usage. A 2x2 analysis of variance will be performed, with gender and usage (active or passive) as the main effects and self-perception scores as the dependent variable.

This hypothesis was modified due to the small sample size (n = 30) and small subgroup sizes (i.e. female passive users = 1, female active users = 3, male passive users = 3, male active users = 5) on which statistical analyses could not be performed. Thus, the original hypothesis was re-formulated to the following:

Re-formulated Hypothesis 4b: FEMALE subjects will have significantly lower (p < .05) self-perception scores, as compared to MALE subjects. A non-parametric Mann-Whitney U test of difference will be performed.

ORIGINAL HYPOTHESIS 5: CONGENITAL amputees who meet the criteria for PASSIVE usage will have significantly lower (p < .05) scores on the perceived social support instruments than CONGENITAL amputees who fit the criteria for ACTIVE usage, and ACQUIRED amputees who fit the criteria for ACTIVE or PASSIVE usage. A 2x2 analysis of variance will be performed, with etiology (congenital or acquired) and usage (active or passive) as the main effects, and the perceived social support scores as the dependent variable.

This hypothesis was re-formulated due to characteristics of the sample as all subjects who completed the study (n = 30) were congenital amputees. As noted earlier, the number of subjects who actually used the myoelectric also was small (n = 12) before a division of subjects into active and passive usage patterns. Thus, the hypothesis was re-formulated to consider the differences in perceived social support scores between users (active and passive) and non-users, as follows:

Re-formulated Hypothesis 5: Subjects who are NON-USERS will have significantly higher (p < .05) perceived social support scores than subjects who are USERS. A non-parametric Mann-Whitney U test of difference will be performed.

ORIGINAL HYPOTHESIS 6a: Subjects who are found to have a HIGH LEVEL OF FAMILY CONFLICT and who met the criteria for PASSIVE usage will have a significantly higher (p < .05) mean number of hours of myoelectric wear per week, as compared to those with a HIGH LEVEL OF FAMILY CONFLICT and
fit the criteria for ACTIVE usage and those with a LOW LEVEL OF FAMILY CONFLICT and fit the criteria for either ACTIVE or PASSIVE usage. A 2x2 analysis of variance will be performed, with degree of family conflict (high or low) and usage (active or passive) as the main effects and the mean number of hours of myoelectric wear per week as the dependent variable.

The hypothesis was re-formulated, due to characteristics of the sample. As noted earlier, the number of subjects who actually used the myoelectric also was small (n = 12) before a division of subjects into active and passive usage patterns, or further into high and low conflict subgroups, which resulted in insufficient subgroup sizes (i.e. High Conflict/Active = 3, High Conflict/Passive = 2, Low Conflict/Active = 5, Low Conflict/Passive = 2) upon which to conduct analysis. Thus, the hypothesis was re-formulated to the following:

Re-formulated Hypothesis 6a: Subjects with a HIGH LEVEL OF FAMILY CONFLICT will have a significantly higher (p < .05) mean number of hours of myoelectric wear per week, as compared to those subjects with a LOW LEVEL OF FAMILY CONFLICT. A non-parametric Mann-Whitney U test of difference will be performed.

ORIGINAL HYPOTHESIS 6b: Subjects with a LOW LEVEL OF FAMILY ORGANIZATION who fit the criteria for PASSIVE usage will have a significantly higher (p < .05) mean number of hours of myoelectric wear per week, as compared to those subjects with LOW LEVEL OF FAMILY ORGANIZATION who fit the criteria for ACTIVE usage and those subjects with a HIGH LEVEL OF FAMILY ORGANIZATION who fit the criteria for ACTIVE or PASSIVE usage. A 2x2 analysis of variance will be performed, with the level of family organization (high or low) and usage (active or passive) as the main effects and the mean number of hours of myoelectric wear per week as the dependent variable.

This hypothesis was re-formulated, due to the same sample and subgroup size issues described for Original Hypothesis 6a, to the following:

Re-formulated Hypothesis 6b: Subjects with a LOW LEVEL OF FAMILY ORGANIZATION will have a significantly higher (p < .05) mean number of hours of myoelectric wear per week, as compared to those subjects with a HIGH LEVEL OF FAMILY ORGANIZATION. A non-parametric Mann-Whitney U test of difference will be performed.
<table>
<thead>
<tr>
<th>Subscale</th>
<th>PIC (ages 4-7, n = 11)</th>
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<tbody>
<tr>
<td></td>
<td>Cognitive Ability</td>
</tr>
<tr>
<td></td>
<td>Physical Competence</td>
</tr>
<tr>
<td></td>
<td>SPPC (ages 8-12, n = 15)</td>
</tr>
<tr>
<td></td>
<td>Scholastic Ability</td>
</tr>
<tr>
<td></td>
<td>Social Skills</td>
</tr>
<tr>
<td></td>
<td>Athletic Ability</td>
</tr>
<tr>
<td></td>
<td>Physical Appearance</td>
</tr>
<tr>
<td></td>
<td>Behavior</td>
</tr>
<tr>
<td></td>
<td>Global Self-Perception</td>
</tr>
<tr>
<td></td>
<td>SPPA (ages 13-17, n = 4)</td>
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<td></td>
<td>Scholastic Ability</td>
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<tr>
<td></td>
<td>Social Skills</td>
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<td>Athletic Ability</td>
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<td>Global Self-Perception</td>
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<table>
<thead>
<tr>
<th>Subscale</th>
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<td>Parent</td>
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<td>Classmate</td>
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<td>Teacher</td>
</tr>
<tr>
<td></td>
<td>Close Friend</td>
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<td>Overall (n=29)</td>
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<td>Cohesion</td>
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<td>Achievement</td>
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<td>Control</td>
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<td>Week 4</td>
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### Table 4

**Active vs Passive Usage Compared on Mean Weekly Hours of Myoelectric Wear**

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<th></th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>MWU</th>
<th>P</th>
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<td>2.29</td>
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<td><strong>Passive (n = 4)</strong></td>
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<tr>
<td>Mrank</td>
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<tr>
<td></td>
<td>7.1</td>
<td>3.98</td>
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<td>2.14</td>
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<td>7.1</td>
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<td>3.77</td>
<td>5.3</td>
<td>2.11</td>
<td>4.4</td>
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<td>Females (n = 14)</td>
<td>Males (n = 16)</td>
<td>MWU</td>
<td>P</td>
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<tr>
<td></td>
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<td>M</td>
<td>SD</td>
<td>Mrank</td>
<td>M</td>
<td>SD</td>
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Table 6

Females vs Males Compared on Self-Perception Scores

<table>
<thead>
<tr>
<th>SPPC Subscales</th>
<th>Females (n = 7)</th>
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<th>Males (n = 7)</th>
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<td>Scholastic Ability</td>
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<td>18.86</td>
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<td>Social Skills</td>
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<td>4.81</td>
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<td>20.29</td>
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<td>Athletic Ability</td>
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<td>SSSC Subscales</td>
<td>Users (n = 6)</td>
<td>Non-users (n = 13)</td>
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<td>--------------</td>
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</tr>
<tr>
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<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
<td></td>
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<tr>
<td>Parent</td>
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<td>1.67</td>
<td>22.61</td>
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<td>Classmate</td>
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<tr>
<td>Teacher</td>
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<td>1.60</td>
<td>20.61</td>
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<td>6.22</td>
<td>19.77</td>
<td>4.75</td>
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Table 8
Level of Family Conflict Compared on Mean Weekly Hours of Myoelectric Wear

<table>
<thead>
<tr>
<th></th>
<th>High (n = 10)</th>
<th>Low (n = 19)</th>
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<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Week 1</td>
<td>2.20</td>
<td>2.52</td>
</tr>
<tr>
<td>Week 2</td>
<td>2.16</td>
<td>2.68</td>
</tr>
<tr>
<td>Week 3</td>
<td>2.03</td>
<td>2.50</td>
</tr>
<tr>
<td>Week 4</td>
<td>2.30</td>
<td>2.74</td>
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</table>
Table 9

Level of Family Conflict Compared on Mean Weekly Hours of Myoelectric Wear (4-12 Yr. Olds Only)

<table>
<thead>
<tr>
<th></th>
<th>High (N = 10)</th>
<th></th>
<th>Low (N = 15)</th>
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</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>2.20</td>
<td>2.52</td>
<td>0.92</td>
<td>1.67</td>
</tr>
<tr>
<td>Week 2</td>
<td>2.16</td>
<td>2.68</td>
<td>1.32</td>
<td>2.92</td>
</tr>
<tr>
<td>Week 3</td>
<td>2.03</td>
<td>2.50</td>
<td>1.34</td>
<td>3.17</td>
</tr>
<tr>
<td>Week 4</td>
<td>2.30</td>
<td>2.74</td>
<td>1.32</td>
<td>3.12</td>
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Table 10

Level of Family Organization Compared on Mean Weekly Hours of Myoelectric Wear

<table>
<thead>
<tr>
<th></th>
<th>High (n = 19)</th>
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<th>Low (n = 10)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Week 1</td>
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<td>1.66</td>
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<td>Week 2</td>
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<td>1.16</td>
<td>2.92</td>
<td>1.88</td>
<td>2.54</td>
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</table>
REFERENCES


Management of the Upper Limb Amputee (pp. 92-98). New York: Springer.


