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# Paraplegic Functional Ambulation with Long Leg Braces and Upper Extremity Support: Predicting Long Term Usage Patterns Utilizing the Functional Independence Measure

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# PARAPLEGIC FUNCTIONAL AMBULATION WITH LONG LEG BRACES AND UPPER EXTREMITY SUPPORT: PREDICTING LONG TERM USAGE PATTERNS UTILIZING THE FUNCTIONAL INDEPENDENCE MEASURE

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## ABSTRACT

Individuals with a spinal cord injury (SCI) are frequently taught to ambulate with long leg braces and upper extremity support during their post-acute rehabilitation. In many cases this training fails to carry over once these individuals return to their homes after their rehabilitation course has ended. Subsequently, these individuals rely on their wheelchair as their primary mode of ambulation. Is ambulation training an appropriate intervention for patients in these cases? The purpose of this study was to investigate whether utilization of the Functional Independence Measure (FIM) may serve as a predictor of long term functional ambulation with long leg braces by individuals with a complete SCI at the level of T12-L3. Based on the data collected, we were unable to determine that there is a relationship between total discharge FIM scores and long term functional ambulation in individuals with a SCI between the level of T12 and L3.

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## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

Figure Page

## OPERATIONAL DEFINITIONS

Functional Ambulation:

1. Requires assistance with bed and wheelchair mobility but is able to walk with long leg braces in the home (50 feet) with no more than minimal assistance for balance, negotiation of barriers, etc. Utilizes a wheelchair for mobility outside the home.

2. Able to walk for reasonable distance unassisted (between 150 and 500 feet) utilizing crutches and/or long leg braces in and out of the home. Wheelchair use is reserved for distances greater than 500 feet.

Individuals With A Spinal Cord Injury: Those individuals with a complete lesion of the spinal cord between levels T12 and L3.

Long Leg Brace: Hip-knee-ankle-foot orthosis or knee-ankle-foot orthosis.

Long Term Functional Ambulation: Ambulation with long leg braces and/or assistive device one year or greater.

Influencing Factors: Any element which may affect the subject's ability to ambulate with long leg braces on a long term basis. This includes, but is not limited to comorbid conditions, secondary complications related to the spinal cord injury, mental capacity, alcohol/drug abuse, socioeconomic status, spiritual beliefs, familial support.

# CHAPTER ONE

# INTRODUCTION

## Background to Problem

Individuals with a spinal cord injury (SCI) are a patient population regularly seen by physical therapists. There are 200,000 current cases, and the incidence rises by 11,000 each year (O'Sullivan and Schmitz, 1994). Disruption to the spinal cord in injuries such as these results in paralysis of the muscles and lack of sensation in the region of the body below the spinal cord level of the lesion. A ramification of this situation is the abrupt realization that the injured individual will suffer a disability for the rest of his/her life. A frequent inquiry is, "will I ever walk again?". Nene, Hermens, and Zilvold (1996) stated that the "inability to walk is the major disability a paraplegic person has and he/she experiences immense social pressures to attain an upright posture and walk again". This is a legitimate concern. Current practice during rehabilitation of an individual with a SCI is to incorporate gait training during their primary stay in the hospital. This is to ensure that each patient is given the opportunity to at least try to walk prior to resigning themselves to a lifetime spent in a wheelchair (T. Lesch, personal communication, February, 1998). Gait training also serves to allow the patient the physiological advantages of an upright position such as improved circulation, cardiovascular endurance, bowel and bladder function, digestion, self image, and decreased decubiti, renal calcification, spasticity, and osteoporosis (Anson and Shephard, 1996; Nene et al., 1996; Coghlan, Robinson, Newmarch, and Jackson, 1980; Hong, San Luis, and Chung, 1990).

Gait training individuals with a SCI involves countless hours of patient education, orthotic fitting, donning and doffing of braces, identifying appropriate safety concerns,

strengthening exercises, balance activities, and ambulation trials within the clinic to ensure functional independence. Stineman, Goin, Granger, Fiedler, and Williams (1997) indicated that functional independent ambulation can be achieved by individuals with a SCI. However, due to the significant cost of gait training procedures, "demands are being placed on practitioners to justify [these] costs". This is significantly important since many of the patients who complete gait training and return to home with long leg braces abandon them and subsequently rely on their wheelchair as their primary mode of mobility (Rosman and Spira, 1974; Coghlan et al., 1980; Mikelberg and Reid, 1981; Hong et al., 1990). Clinicians would be better equipped to facilitate optimal rehabilitation outcomes, and therefore deter abandonment, if they could attain "quantitative knowledge of how their interventions affected patient's capacity to recover function" (Stineman et al., 1996). Therefore, in order to prove the effectiveness of rehabilitation and justify those interventions, an objective functional measure is required.

The Functional Independence Measure (FIM) is utilized as a standard tool for objective functional measurements of patients nationwide. Through the application of the FIM, it may be possible that health care professionals will be able to address the rising concerns of appropriate interventions as mentioned above. Specifically, rehabilitation professionals can incorporate the information provided by the FIM to establish the quantitative knowledge that is required to determine the effectiveness of gait training individuals with a SCI who otherwise might not be functionally appropriate.

Problem Statement

The significant cost of gait training for individuals with a SCI is a concern, considering the fact that many patients do not follow through with this form of

ambulation post discharge. Limited research has been conducted concerning this issue, and the main focus for previous studies has been long term usage of long leg braces for ambulation and reasons for abandonment (Rosman and Spira, 1974; Coghlan et al., 1980; Mikelberg and Reid, 1981; Hong et al., 1990). An evidence-based element is needed that will help physical therapists in their decision making process during initial rehabilitation regarding whether gait training is appropriate for an individual with a SCI.

Purpose

The purpose was to investigate whether utilization of the FIM may serve as a predictor of long term functional ambulation with long leg braces by individuals with complete SCI at the level of T12-L3. A sample of 50 charts from individuals with SCI from Mary Free Bed Hospital and Rehabilitation Center, Grand Rapids, Michigan and Rehabilitation Institute of Michigan, Detroit, Michigan were reviewed to serve as a source for data collection.

Significance of the Problem

This issue is significant based on the current practice during rehabilitation in which most individuals with a SCI participate in gait training. Individuals with a SCI have the desire to explore any avenue that will allow them to walk again. Physical therapists urge gait training to ensure that each patient is given at least a chance to reach their fullest functional potential as well as to gain the physiological benefits of posturing in an upright position. These are both legitimate reasons for gait training, however, many of these patients do not continue to ambulate after discharge from the hospital. The expense and significant effort spent during rehabilitation may not be suitable, and this is a

concern. Concurrently, another issue is the lack of an appropriate objective tool to evaluate patients' potential for functional ambulation.

Research Question

Primary Aim: We hypothesized that a relationship existed between FIM scores and long term functional ambulation with long leg braces of individuals with SCI.

Secondary Aim: We hypothesized that the results of our data analysis could be incorporated into a chart format which health care professionals could utilize to predict long term functional ambulation in individuals with a SCI.

# CHAPTER TWO

## REVIEW OF LITERATURE AND CONCEPTUAL FRAMEWORK

The mechanism by which individuals with a SCI are able to ambulate incorporates two components. The first involves providing the appropriate ambulatory assistive device through the utilization of a walker (standard, rollator, or reciprocating) or crutches (axillary or lofstrand). Second, the lower extremities also must be stabilized by bracing systems which overcome the neuromuscular deficits that result from the SCI. A variety of bracing systems are available, depending on the level of support that is needed. This is accomplished through the application of a hip-knee-ankle-foot orthosis (HKAFO), knee-ankle-foot orthosis (KAFO), or an ankle-foot orthosis (AFO) (Nene et al., 1996; Hussey and Stauffer, 1973).

Functional ambulation is categorized into four subgroups as indicated by Rancho Los Amigos Hospital's criteria (Hussey and Stauffer, 1973). Community ambulation includes the ability to walk for a reasonable distance unassisted, but in and out of the home the patient may require the use of crutches or braces. Wheelchair use is reserved for exceptionally long distances. Household ambulation involves assistance with bed and wheelchair mobility, ability to walk in the home with relative independence and utilization of a wheelchair for mobility outside of the home. Exercise ambulation requires controlled conditions and adequate assistance with functional mobility acquired through wheelchair utilization. Non-ambulatory patients depend on their wheelchair as their primary mode of mobility. According to Ranchos Los Amigos, both "community and household ambulation are considered functional ambulation" (Hussey and Stauffer, 1973).

Research Studies: Long Term Ambulation and Usage of Orthoses

A review of the literature showed that limited research has been conducted regarding long term usage of long leg braces for ambulation. In fact, less than ten articles have been published on this particular topic since 1966. This limited research has contributed to the current practice of continued orthotic prescription and lengthy gait training for a number of individuals with a SCI who are apparently not appropriate for this type of activity or goal (T. Lesch, personal communication, February, 1998).

A study conducted by Rosman and Spira (1974) surveyed individuals with a SCI and their use of walking braces for ambulation. The patient population included 51 patients with injuries from T1-L5. Subjects were categorized according to lesion level. The strict criteria for the utilization of walking braces for ambulation was only considered positive if the patient used their braces daily. Responses were considered negative if the subjects used their braces weekly or monthly. The objective results of the survey revealed that in the T1-T6 category, one out of the seven respondents was using the braces for standing only. In the T7-T11 category there were 23 respondents; one patient used braces for walking, and four used them for standing. The T12-L1 category included 12 subjects, of which three used braces for walking and two used them for standing. The final group consisted of subjects with damage in the L2-L5 category. There were four respondents and two used braces for walking and one used them for "partial walking". The authors of the study concluded that in cases where damage is sustained to spinal cord levels T12-L1, there are a significant number of patients who continue to ambulate with long leg braces; therefore continued brace prescription is indicated. However, the authors postulated that long leg brace prescription is inappropriate in patients with lesions above

T12, and a better alternative would be to issue splints for standing exercises. Rosman and Spira recognized that further investigation is warranted.

A follow-up study on individuals with a SCI and their use of lower extremity bracing conducted in 1980 by Coghlan et al., revealed interesting results. A survey of 98 individuals with a SCI was conducted to determine if patients were still using their braces, and possible reasons for abandonment. The subjects were divided into categories that included: presence of muscle power, spasticity vs. flaccidity, and walkers/occasional walkers vs. exercise walkers and standers. The data revealed that "57 patients did not use their braces at all, six used braces for standing only, 19 used them for standing and exercise walking, three used them for occasional walking, and 13 used them for functional walking. Functional walking was defined as "daily use for practical mobility". Occasional functional walking was defined as "use on a less than daily basis". The majority (38 out of 41) of the patients that were still using the braces felt that the prescription was appropriate. Interestingly, 38 of the nonusers also felt that the prescription was appropriate, indicating a potential psychosocial component of ambulation. The reasons for abandonment included: "timeliness, practicality, energy expenditure, safety, spasticity, inappropriate terrain, sore shoulders, lack of encouragement/motivation, and ease of wheelchair use". Categorical data revealed that "a large group of the non-brace users did not have the physical capability to become functional walkers", especially those who lacked abdominal musculature and leg musculature of 2+ or less (out of five) as obtained from a manual muscle test. The authors emphasized the belief that "hip hikers, full abdominals and lumbar back extensors are the minimum requirements for functional walking by paraplegics". Coghlan et al.

also acknowledged that there are physiological benefits of an upright position, as provided by brace walking; however the authors did not feel that these benefits alone can justify the extensive processes that are undertaken in the prescription of braces and subsequent training to use them. Coghlan et al. felt that "certain indices can help with decision making" prior to training. These indices briefly included: motivation, pre-morbid behavior, and level of paralysis. The remaining individuals with SCI could potentially benefit from a standing frame rather than expend efforts to gait train with braces. The authors of this study proposed two concepts. First, "considerable cost could have been saved by modifying gait training to exclude stair climbing, ramps, and rough ground" which are apparently not practical for this population. Second, a study pertaining to the history of brace use was indicated to determine at what point patients begin to wane from their ambulation.

Another similar study was conducted by Mikelberg and Reid in 1981 to investigate brace usage and efficacy. Thirty-five individuals with SCI age 15 and older were surveyed regarding the use of lower extremity braces. Patients were classified according to length of their braces and level of their lesion. The results revealed that 60% used a wheelchair, 20% used both a wheelchair and braces, and 17% used braces. The reasons for abandonment included: difficulty and time, illness, weight, and poor adjustment. Conversely the reasons for utilization ranged from psychological factors, architectural barriers, exercise, and standing. In agreement with the results of Coghlan et al. (1980), Mikelberg and Reid also emphasized the need for certain criteria to be analyzed prior to the prescription of braces. These elements included: need, motivation, age, physical condition, and financing. The authors of the study questioned the

"prescription of bracing on first admission" and recommended brace prescription upon a reevaluation period with a proposal for an alternate means of standing for patients who do not meet the gait training criteria.

A subsequent follow-up study was conducted in 1990 by Hong et al., to investigate leg brace use and influencing factors. Seventy-three subjects were surveyed. The results reported that 22% continued to use their braces for either community ambulation, household ambulation, or exercise ambulation. There was no clear definition of these categories. All 22% were lesioned at T9 or below and the majority were incomplete SCI. Seventy-eight percent of the subjects were non-ambulatory, with 13 using the braces for standing only. The authors noted that 14% of the nonusers discontinued brace use within six months after discharge, 74% discontinued use between six and twelve months, and the remainder abandoned use between one and three years. This behavior was "significantly related to level of lesion, severity of injury, medical complications, and independence with ADL" as paralleled by the results found by Coghlan et al. (1980) and Mikelberg & Reid (1981). Hong et al., also recommended that in situations where ambulation with braces is not appropriate, the utilization of standing splints is beneficial, as previously stated by Rosman and Spira (1974) and Mikelberg and Reid (1981). Finally, Hong et al. highly recommended that brace usage be reinforced "every 6 months" in the clinic to facilitate continued functional ambulation with long leg braces.

Hawran & Biering-Sorensen (1996) reported on their follow-up study of long leg brace usage of patients discharged between 1973 and 1982. Their results were disappointing. A medical record review of charts served as the basis for the 40 subject

sample population. Upon discharge, 22 patients used braces to stand and walk, 11 for standing, five only during rehabilitation, and two for stair climbing. Six subjects never used their braces after discharge. The follow-up indicated that only three of the original 40 were still "using" their braces. One subject used the braces once a week for standing and walking, another used them for standing every two weeks, and the last used the braces for stair climbing once every two months. The majority of the subjects felt that the long leg braces were too difficult to don and doff. Subjects' remaining concerns included: fear of falling, impracticality, motivation, and spasticity. The authors noted that the majority of the remaining subjects would have preferred, and subsequently requested, a standing frame.

Finally, a study by Natvig and McAdam (1978-1979) revealed significantly contrasting information regarding ambulation with leg braces post SCI. The study analyzed three subsets of gait training activity after the conclusion of their SCI rehabilitation protocol: (a) "Ability to cope with 20 standard stairs with crutches, (b) ability to walk 100 meters indoors with crutches, (c) ability to walk 500 meters outdoors with crutches". Patients were categorized according to level of lesion. The first category included patients with T1-T5 lesions. The results revealed the following information: seven patients were able to cope with stairs, seven walked 100 meters indoors, and one patient walked 500 meters outdoors. The T6-T10 level of lesion category indicated that 13 patients were successful with stairs, 12 walked 100 meters indoors and 7 walked 500 meters outdoors. Finally, the level of lesion category T11-L3 revealed that 11 patients were able to cope with stairs, 11 walked 100 meters, and 8 walked 500 meters outdoors. The authors' conclusion stated that "74% [of patients] were able to climb 20 stairs with

crutches, 71% could walk 100 meters indoors with crutches, and 37% were able to ambulate 500 meters with crutches". Natvig and McAdam did not give any information regarding the length of time required for successful ambulation, the amount of physical assistance required, or the type of brace and/or crutches the client was using. Although the article indicated that this was a follow-up study, there was no information regarding how many of these patients were still ambulating post discharge; therefore a retrospective study is a more appropriate description of the results described by the authors. The information presented by Natvig and McAdam is in direct contrast to the previous studies that were reviewed.

In the cases of these surveys, the determination of "use" and the corresponding definition of functional ambulation is being determined by the subjects themselves. The researchers were unable to control for subjects' bias, misunderstanding of questionnaires, or their ability to judge/remember the frequency of their usage. These inaccuracies could lend to skewing of the data presented in the studies were reviewed and ultimately lead to questionable validity of the results.

FIM: Background Information

The FIM is a tool that is "used to determine the degree of disability that patients experience and the progress that they make through programs of medical rehabilitation" (Granger, Hamilton, Linacre, Heinemann, and Wright, 1993). The FIM is part of the Uniform Data System for Medical Rehabilitation and is utilized by approximately 60% of rehabilitation facilities nationwide (Stineman et al. 1997) as well as internationally (Ottenbacher, Hsu, Granger, and Fiedler, 1996). The FIM is divided into six sections that measure self-care, sphincter control, mobility, locomotion, communication, and social

cognition. These elements comprise 18 areas of function, which measure disability based on a maximum 126 point scale. Each number is assigned to a predetermined level of function. Levels one and two indicate patients who are dependent on others; levels three, four, and five encompass individuals which require assistance; levels six and seven indicate varying degrees of independence (Granger et al., 1993). Refer to appendices A-D for a copy of the FIM and the associated categories and scoring criteria.

The FIM has evolved as a strong testing instrument after going through many "methodological evaluations" (Dodds, Martin, Stolov, and Deyo, 1993). Dodds et al. examined the FIM's reliability, temporal responsiveness, and construct validity in a study of all patients that participated in rehabilitation in a Northwest Association of Rehabilitation Facility between 1988 and 1990. "FIM scores were collected at admission and discharge for every patient" in accordance with standard FIM procedures. Patients were stratified according to their condition. The data was analyzed using the Statistical Program for the Social Sciences. The internal consistency of the FIM was demonstrated as reliable with an alpha of .93 and .95 for admission and discharge, respectively, and individual items were shown to be highly correlated. Internal consistency for the locomotion portion of the FIM indicated a discharge alpha of .68, indicating that "items may be measuring different constructs" (Dodds et al., 1993). This is of particular importance to our study because the alpha was .41 in the SCI population thus indicating a lack of internal consistency of the locomotion subscale. Dodds et al. recommended that "one could either add more items that assess locomotion-related disability or create separate subscales for ambulation and stair climbing". The temporal responsiveness of

the FIM was significant; all patients improved between admission and discharge. The authors of the study acknowledge that this "may be due to natural recovery or scorer bias". Finally, the FIM was able to "discriminate differences among patients with varying degrees of comorbid conditions. There were significant declines in FIM scores as comorbidity increased". Another important note applicable to our study is that there were "statistically significant differences in FIM scores between SCI patients who had differing levels of impairment severity. Discharge FIM scores monotomically decreased" with increased severity.

A study performed by Ottenbacher et al. (1996) quantitatively analyzed former research on the "reliability of the adult FIM". A total of eleven studies were investigated and an emphasis was placed on "synthesizing three types of FIM reliability: interrater, test-retest, and equivalence reliability". The results revealed that "the FIM provides good interrater reliability across a wide variety of raters with different professional backgrounds and levels of training". The median value was .95 with a 95% confidence interval with values between .915 and .925. The values for test-retest and equivalence were .95 and .92, respectively. The authors of the study noted that there was "no control for professional affiliation and background...the impact of professional backgrounds could not be statistically examined".

In accordance with the above information, Dodds et al. (1993) stated "whereas the FIM is a strong indicator of physical needs and cognitive impairments, it does not measure the social, psychological, and vocational impact of disability. Moreover, the

FIM does not measure quality of life or patient satisfaction". These are factors which could affect the resulting data analysis and interpretation of this study.

Other Influencing Factors

Long term ambulation with long leg braces may not be appropriate for every individual with a SCI. As previously mentioned, a variety of factors must be taken into consideration including age, weight, motivation/support groups, level of injury and/or independence, physical conditioning/energy expenditure (Rosman and Spira, 1974; Coghlan et al., 1980; Mikelberg and Reid, 1981; Nene et al., 1996). Accordingly, the study by Hong et al., (1990) revealed through statistical analysis that "discontinued usage of braces for ambulation was not related to length of initial hospitalization, years after injury, marital status, educational level, living arrangements, social activities; but was related to age, level of injury, medical problems, and dependence for ADL".

Level of Lesion

Long and Lawton (1955) proposed that only extraordinary patients with lesions above T12 could master functional ambulation and that independent ambulation could only be accomplished by individuals with injuries below the level of L4. A study by Hussey and Stauffer (1973) indicated some encouraging results that relied more on motor control and proprioception. Patients who wished to be community ambulators should have "good pelvic control and active hip flexors and preferably at least one quadriceps muscle with function in the fair or better range" as obtained through manual muscle testing. Concurrently, the authors discovered that proprioception in the hip and knee joints was also required. Hussey and Stauffer (1973) proposed that patients with a lower neuromuscular function, increased age, and/or deformity and spasticity could still achieve

household ambulation if they retained a motor presentation similar to that described above, however, "pelvic control is an essential minimum and the presence of active hip flexors is necessary for the majority of the patients".

Energy Requirements

Several studies have been conducted regarding the energy requirements for ambulation with long leg braces. Waters, Yakura, and Adkins (1993) demonstrated that walking was a significantly more demanding activity for individuals with a SCI when compared with normal individuals. The study revealed that individuals with a SCI had a 52% slower velocity, 23% greater oxygen consumption, and 240% higher oxygen cost per meter. Oxygen consumption was defined as milliliters of oxygen per kilogram times one minute. This determines the intensity of sustained exercise and is related to the length of time that the exercise can be performed. Oxygen cost was defined as milliliters of oxygen per kilogram times one meter which is the amount of oxygen needed to walk a unit distance. A study by Huang, Kuhlemeier, Moore, and Fine (1979) showed that paraplegic individuals consumed three times greater oxygen during walking than at rest. Concurrently, Miller, Merrit, Merkel, and Westbrook (1984) discovered that energy consumption during "negotiations of architectural barriers was approximately the same as that for able bodied walkers, however energy cost was 15 times greater".

A few studies have investigated energy consumption related to lesion level. Clinkingbeard, Gersten, and Hoehn (1964) found that the energy cost of locomotion decreased as the level of the lesion decreased, however the energy consumption increased. The authors postulated that is was due to the "increased speed of walking as the lesion level decreased". Finally, Merkel, Miller, and Merrit (1985) showed that

individuals with a SCI with lesions at low or mid thoracic level had energy costs of 25 times that of normal walkers. This research supports the statement by Coghlan et al., (1980) and Rosman and Spira (1974) that "the high energy expenditure of paraplegic ambulation does not allow the aged and sick subjects to sustain this high cardiopulmonary stress".

Secondary Complications

Secondary complications can often be seen in individuals with a SCI. Anson and Shephard (1996) investigated 348 subjects and found a high incidence of comorbidity in individuals with a SCI including pressure sores, obesity, spasticity, pain, and bladder problems. The authors found that "only 4.4% of patients with chronic SCI were free of medical complications at the time of their routine physical exam". Fifty-eight percent of the sample population suffered from three or more complications, with some appearing to be interrelated. Anson and Shephard concluded that "at least in some cases, the presence of a secondary condition is a risk factor for further illness, and in some with increased morbidity".

Summary

The significant priority that is placed on the ability to ambulate following a SCI has resulted in a focus on gait training of some individuals who otherwise might not be functionally appropriate for that goal. Research regarding the effectiveness of long term functional ambulation with long leg braces has been sketchy and findings have ranged from disappointing, as represented by Hawran and Biering-Sorensen (1996) where upon follow-up only three of the original subjects were still using braces for ambulation, to Natvig and McAdam (1978-1979) who claimed up to 74% ambulation success with SCI

patients. Unfortunately without consistent and ample research, current intervention practices will continue. However, an objective measure such as the FIM can be utilized with each individual with a SCI during the decision-making process regarding the appropriateness of gait training with long leg braces. The FIM has established validity and reliability as represented by Dodds et al. (1993) and Ottenbacher et al. (1996). Despite the poor internal consistency of the locomotion portion of the FIM, especially for the SCI population, total FIM scores have been shown to be internally consistent, temporally responsive, reliable between inter-rater, test-retest, and equivalency. Therefore, it is an appropriate indicator of a patient's level of disability and can be beneficial when working with the SCI population.

# CHAPTER THREE

# METHODS

## Design of the Study

The study design incorporated step-wise discriminant analysis and logistic regression which are powerful and effective statistical tools for explaining and predicting quantifiable clinical outcomes. The use of step-wise discriminant analysis and/or logistic regression would help to illustrate the relationship between multiple variables: one independent, or predictor, variable and several dependent, or criterion, variables (Portney and Watkins, 1993). Therefore, the independent variable were FIM scores and the dependent variables were whether or not the subjects were functionally ambulating according to the inclusion criteria. Thus, the purpose of this study was to investigate whether FIM scores would serve as a predictor of long term functional ambulation with long leg braces by individuals with a SCI. Additional subject information was collected during chart reviews including age, gender, level of lesion, date of injury, influencing factors, date the orthotic braces were issued, and ambulation distance to allow us to consider and draw conclusions from these factors which may have affected the data analysis. Upon conclusion of the data collection process descriptive statistics were utilized to analyze the data that was actually collected.

## Subjects: Phase I

The study sites included Mary Free Bed Hospital (MFB) and Rehabilitation Center, Grand Rapids, Michigan and Rehabilitation Institute of Michigan (RIM), Detroit, Michigan. Preliminary subjects for this study were attained as a sample of convenience; in the event that there was an abundance of records in which a subject pool could have

been established, systematic random sampling would have enabled us to develop our subject population. The target population was obtained from a list of individuals with a SCI who received rehabilitation at MFB Hospital and Rehabilitation Center and RIM. A table of random numbers would have been used to chose a starting point within the list of possible subjects if the population was greater than a sample of convenience. Every fifth subject would have been selected until a sample of 50 subjects was reached. Data Collection Form I was utilized to document individual subject information to contribute to future statistical analysis. Please refer to appendix E for a copy of Data Collection Form I. Those subject charts meeting the following inclusion criteria were included for the preliminary data collection.

Inclusion criteria: Phase I

1. Subjects admitted to MFB Hospital and Rehabilitation Center and RIM with a complete SCI between the level of T12 and L3.
2. Male and female subjects between 18 and 65 years of age.
3. Subjects whose admission and discharge FIM scores were recorded during their acute rehabilitation stay at MFB Hospital and Rehabilitation Center and RIM.
4. Subjects who received gait training with long leg braces during their rehabilitation at MFB Hospital and Rehabilitation Center and RIM.
5. Subjects whose ambulatory status with long leg braces was recorded at or near the end of their gait training as obtained from outpatient rehabilitation charts including ambulation distance and amount of assistance required.
6. Subjects whose discharge from outpatient rehabilitation was at least six months, but no longer than two years, prior to the date of the interview.

Instrumentation: Phase I

Data Collection Form I was utilized to gather and organize subject information recorded during the chart review process for the preliminary subject population. Mary Free Bed Hospital and Rehabilitation Center and RIM utilize the FIM upon admission and discharge for each subject's acute stay in the hospital. Objective information regarding each subject's progress is also recorded by the rehabilitation staff during the subject's course of outpatient rehabilitation. Therefore, total FIM scores upon admission and discharge from acute rehabilitation were recorded along with outpatient physical therapy information regarding ambulatory status with long leg braces at or near the time of discharge including distance and amount of assistance required as assessed by a physical therapist.

Subjects: Phase II

Subjects for this phase of the research were attained as a sample of convenience based on those who met the second phase of inclusion criteria.

Inclusion Criteria: Phase II

1. Subjects who met inclusion criteria, phase I as described above.
2. Subjects who were functionally ambulating with long leg braces at or near the termination of outpatient rehabilitation.

Instrumentation: Phase II

Data Collection Form II would have been utilized to compile information from subjects who met inclusion criteria, phase II. Please refer to appendix F for a copy of Data Collection Form II.

Subjects: Phase III

Subjects for the final subject population would have been attained as a sample of convenience. New information would have been obtained and added to data that had already been recorded on Data Collection Form II (appendix F). The subjects who met our final phase of inclusion criteria were to comprise our final sample population.

Inclusion Criteria: Phase III

1. Subjects who met inclusion criteria, phase II.
2. Subjects who, upon verbal or written agreement, would have been interviewed by phone as to their ambulatory status with long leg braces including whether or not they were continuing to ambulate, ambulation in the home and/or community, frequency of ambulation per week, and the amount of assistance required for ambulation.

Instrumentation: Phase III

Data Collection Form II would have been utilized to add the pertinent information gathered during the proposed phone interview of the subjects. The verbal and/or written consent form (appendix H & I) would have been utilized to ensure subject's consent to participate in the study prior to the interview process.

Procedure

Approval was requested through the Human Subjects Review Board at MFB Hospital and Rehabilitation Center, RIM, and Grand Valley State University. Following this procedure, the preliminary population of subjects was selected. Chart reviews were completed during phase I and the following information was recorded on the data collection form: (a) Subject name, (b) medical record number, (c) date of birth, (d) gender, (e) level of lesion, (f) date of injury, (g) influencing factors, (h) date braces were issued, (i) total FIM scores upon admission and discharge from acute rehabilitation, (j) ambulatory status (functional versus nonfunctional) at or near the termination of outpatient rehabilitation as obtained from outpatient charts, (k) date of discharge from outpatient rehabilitation. The subject's name was recorded in order for us to track the chart from acute rehabilitation to outpatient rehabilitation to continue our data collection. The medical record number and date of birth were also recorded to serve as another element to assist with chart identification.

A secondary sample of subjects would have been obtained from those subjects who met the inclusion criteria, phase II. The researchers proposed to review only those outpatient rehabilitation charts which met the inclusion criteria, phase II to record the following data: (a) Subject name, (b) subject phone number, (c) subject address. Upon agreement by the subject via verbal or written consent, the final sample of subjects would have been interviewed by phone and the following information would have been added to Data Collection Form II: (a) Continuation of ambulation with long leg braces after discharge from outpatient rehabilitation (yes or no), (b) ambulation in the home and/or in

the community, (c) frequency of ambulation per week, (d) amount of assistance required during ambulation.

Upon conclusion of the proposed interview process, pertinent information from Data Collection Forms I and II from the final sample population would have been transferred to Data Collection Form III. This form would have contained only the information pertinent to the study and it would not have included the subject's name, address, or phone number to protect subject confidentiality.

Data Analysis

The data that was to be collected would have been analyzed through step-wise discriminant analysis or logistic regression based on the available data that was collected. Step-wise discriminant analysis and logistic regression are multivariate statistical methods for distinguishing between two or more groups. Individual groups are established by a set of characteristics that are predictors of group membership (Portney and Watkins, 1993). In the statistical analysis total FIM scores would have been analyzed to predict the relationship between functional and non-functional ambulation in individuals with a SCI between levels T12-L3. However, based on the available data descriptive statistics were utilized for data analysis.

# CHAPTER FOUR

# RESULTS

## Subject Population

Twenty-three charts were available for review from Mary Free Bed Hospital and Rehabilitation Center. These charts were obtained through the hospital database system according to the level of the subject's SCI which ranged between T7 and L5. Twenty charts were eliminated from the study because the level of lesion did not meet the inclusion criteria of T12-L3. The remaining three charts met the inclusion criteria of T12-L3, however they were later eliminated because the injury was not complete. Consequently, there were no appropriate data to be analyzed from this facility.

A list of 25 possible subjects was obtained through the Rehabilitation Institute of Michigan hospital database system according to their spinal cord injury level. Nineteen charts were available for review. The remaining six charts were unavailable for review. Two charts were excluded secondary to omission of initial injury information. Two charts were excluded secondary to inappropriate level of injury. Finally, two more charts were excluded secondary to lack of physical therapy information. A total of thirteen charts remained and were reviewed for data collection.

## Characteristics of Subjects

The sample population included thirteen males between the ages of 19 and 48 years. The average age at the time of injury was 30.3 years. Eight subjects had a spinal cord injury at the level of T12, four at the level of L1, and one at the level of L3. There were four classifications for the mechanism of injury: multiple gun shot wounds, single

gun shot wounds, a fall, and work accidents. Table 1 illustrates these subject characteristics.

**Table 1**

**Rehabilitation Institute of Michigan Subject Demographics Part I**

| SUBJECT | AGE | GENDER | RACE | LEVEL OF LESION | MECHANISM OF INJURY |
|---|---|---|---|---|---|
| 1 | 19 | M | B | T12 | Multiple GSW |
| 2 | 30 | M | B | T12 | N/A |
| 3 | 48 | M | W | L1 | Work Accident |
| 4 | 24 | M | B | T12 | GSW |
| 5 | 20 | M | B | L1 | GSW |
| 6 | 30 | M | B | T12 | GSW |
| 7 | 37 | M | B | L1 | GSW |
| 8 | 23 | M | B | L1 | GSW |
| 9 | 41 | M | W | T12 | GSW |
| 10 | 21 | M | B | T12 | GSW |
| 11 | 19 | M | B | T12 | Multiple GSW |
| 12 | 35 | M | W | L3 | Fall |
| 13 | 47 | M | W | T12 | Work Accident |

GSW= Gun shot wound
N/A= Information not available in chart

Information regarding each subject's hospital stay and amount of time spent in outpatient physical therapy was recorded. The subject's average acute rehabilitation hospital stay was 31 days (n = 11). Seventy-seven percent of the population received outpatient physical therapy and 23% did not. The average amount of time spent in outpatient physical therapy ranged from 2 months to 6 months and 28 days, with an average length of outpatient therapy lasting 5 months and 13 days (n = 8). Table 2 presents this information. These demographics were not statistically analyzed due to the variability in recorded information between the charts.

**Table 2**

**Rehabilitation Institute of Michigan Subject Demographics Part II**

| SUBJECT | HOSPITAL LENGTH (DAYS) | OUTPATIENT P.T. (YES/NO) | OUTPATIENT LENGTH (DAYS) |
|---|---|---|---|
| 1 | 19 | N | N/A |
| 2 | 60 | Y | N/A |
| 3 | N/A | Y | 199 |
| 4 | 23 | Y | 128 |
| 5 | N/A | Y | 208 |
| 6 | 36 | Y | N/A |
| 7 | 11 | N | N/A |
| 8 | 37 | Y | 112 |
| 9 | 35 | Y | 60 |
| 10 | 17 | N | N/A |
| 11 | 72 | Y | 150 |
| 12 | 39 | Y | 57 |
| 13 | 41 | Y | 187 |

N/A= Information not available in chart

Each subject had multiple factors along with their SCI which could have influenced their ability to ambulate as illustrated by Table 3. The number of these factors ranged from 3 to 15, with an average of 6.3 influencing factors per subject. These factors were positive and negative in nature and were considered equal for the purposes of data collection and analysis. Table 4 lists all forty influencing factors as they applied to each subject.

**Table 3**

**Number of Influencing Factors Per Subject**

| SUBJECT | INFLUENCING FACTORS | SUBJECT | INFLUENCING FACTORS |
|---|---|---|---|
| 1 | 5 | 8 | 5 |
| 2 | 4 | 9 | 4 |
| 3 | 5 | 10 | 8 |
| 4 | 3 | 11 | 15 |
| 5 | 5 | 12 | 4 |
| 6 | 8 | 13 | 6 |
| 7 | 10 | | |

## Table 4

**Rehabilitation Institute of Michigan Influencing Factors**

| RIM: Influencing Factors | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alcohol Abuse | | | | | X | X | | | | | | | |
| Anemia | | | | | | | | | | | X | | |
| Braces Burned | | | X | | | | | | | | | | |
| Children | | | | | | X | X | | | | X | X | X |
| D/C Medical Status/Surgery | | | | | | X | X | | | | | | |
| D/C Due To Personal Reasons | | X | | | | | | | | | X | | |
| Decreased Balance/Endurance | | | | | | | | | | X | | | |
| Decreased Strength/ROM | | | | | | | | | X | X | | | |
| Decubitii | | | | X | | | | X | | | X | | |
| Delirium | | | | | | | X | | | | | | |
| Depression | | | | | | | X | | | | | | |
| DJD | | | | | | | X | | | | | | |
| Drug Use | | | | | | | X | | | X | X | | |
| Fusion (Harrington Rods) | | X | X | | | | | | | | | X | X |
| GSW | | | | | | | X | | X | | | | |
| GSW (Multiple) | X | | | X | X | | | X | | X | X | | |
| Head Injury | | | | | X | | | | | | | | |
| Hypertension | | | | | | | X | | | | | | |
| IDDM | | | | | | | | X | | | | | |
| Lower Extremity Fracture | | | | | | | | | | | X | | |
| Lives Alone | | | | | | | | | | | X | | |
| Lives With Family | | | | | X | | | X | | X | | | |
| Low Back Pain | | | | | X | | X | | | | X | | |
| Married | | | | | | | | | | | | X | X |
| Neurogenic Bowel/Bladder | X | X | X | X | | | X | | | | X | | X |
| No High School Diploma | | | | | | | | | | X | X | | |
| Orthotic Braces Not Covered By Insurance | | | X | | | | | | | | X | | |
| Perinephric Hematoma | X | | | | | | | | | | | | |
| Poor PT Attendance | X | | | | | X | | X | | | X | | |
| Rib Fracture | | | X | | | | | | | | | | X |
| Seizure | X | | | | | | | | | | | | |
| Shoulder Dysfunction | | | | | | | | | X | | | | |
| Sleep Apnea | | | | | | | | | X | | | | |
| Smoker | | | | | | X | | | | | | | |
| TLSO At All Times | | X | | | | | | | | X | | | |
| Tone/Contractures | | | | | | X | | | | | | | |
| Transportation Difficulties | | | | | | X | | | | | | | |
| 12th Grade Education | | | | | | X | | | | | | | |
| Upper Extremity Fracture | | | | | | | | | | | X | | |
| Vertebral Body Fracture | | | | | | | | | | X | X | X | X |
| Total Number of Factors | 5 | 4 | 5 | 3 | 5 | 8 | 10 | 5 | 4 | 8 | 15 | 4 | 6 |

Ambulatory Status

The ambulation distance, type of brace utilized, and the assistive device required for ambulation was recorded for each subject. The initial distance the subjects ambulated during outpatient rehabilitation ranged from two steps to two hundred feet. The discharge ambulation distance ranged from 30 feet to 350 feet. The type of leg braces that were utilized to aid in ambulation varied between subjects and included Craig-Scott orthoses, posterior knee splints, KAFO's, and AFO's. The assistive devices that were utilized to aid with ambulation also varied and included standard walkers, lofstrand crutches, a standard cane, and bilateral short base quad canes. Table 5 represents these elements and their relationship to each subject. These factors also were not statistically analyzed due to the inconsistencies in available information from the charts as previously described.

**Table 5**

**Rehabilitation Institute of Michigan Subject Demographics Part III**

| SUBJECT | INITIAL AMBULATION DISTANCE | DISCHARGE AMBULATION DISTANCE | TYPE OF BRACE UTILIZED FOR AMBULATION | ASSISTIVE DEVICE UTILIZED FOR AMBULATION |
|---|---|---|---|---|
| 1 | N/A | N/A | N/A | N/A |
| 2 | N/A | N/A | N/A | N/A |
| 3 | 30 FT. | 150-200 FT. | SCO | STD. WALKER |
| 4 | N/A | 250 FT. | PKS | STD. WALKER |
| 5 | 200 FT. | 350 FT. | KAFO | STD. WALKER |
| 6 | N/A | 20 FT. | KAFO | PARALLEL BARS |
| 7 | N/A | N/A | N/A | N/A |
| 8 | 2 STEPS | 150 FT. | N/A | STD. CANE |
| 9 | N/A | N/A | N/A | N/A |
| 10 | N/A | N/A | N/A | N/A |
| 11 | 15 FT. | 30 FT. | KAFO | LOFSTRAND |
| 12 | 80 FT. | 300 FT. | AFO | BILATERAL SBQC |
| 13 | 30 FT. | 200 FT. | KAFO | STD. WALKER |

DNA= Did not ambulate
NON= Non-functional ambulator
FXN= Functional ambulator
STD= Standard
AFO= Ankle foot orthosis
KAFO= Knee ankle foot orthosis
PKS= Posterior knee splints
SCO= Scott Craig orthosis
N/A= Not available in Chart

Ambulatory status was broken into three categories. Subjects who ambulated at least 50 feet were considered functional. Subjects who ambulated less than 50 feet were considered non-functional. Finally, there were also subjects who did not ambulate. Forty-six percent of the subjects were functional ambulators, 23% were nonfunctional ambulators, and 31% did not ambulate. Table 6 illustrates these categories and their relationship to each subject. This information was utilized as a basis for further data analysis.

**Table 6**

**Ambulatory Status Per Subject**

| SUBJECT | AMBULATORY STATUS | SUBJECT | AMBULATORY STATUS |
|---|---|---|---|
| 1 | DNA | 8 | FXN |
| 2 | NON | 9 | DNA |
| 3 | FXN | 10 | DNA |
| 4 | FXN | 11 | NON |
| 5 | FXN | 12 | FXN |
| 6 | NON | 13 | FXN |
| 7 | DNA | | |

DNA= Did not ambulate
NON= Non-functional ambulators
FXN= Functional ambulators

Cumulative data analysis revealed specific information on the relationship between ambulatory status and level of lesion. Figure 1 illustrates these relationships. There were eight subjects with a T12 lesion. Out of those subjects, three did not ambulate, three were non-functional ambulators, and the remaining two were functional ambulators. Of the four subjects with a L1 lesion; one subject did not ambulate, and three were functional ambulators. There was one subject with a lesion at the level of L3, and he was a functional ambulator. Figure 1 illustrates these relationships.

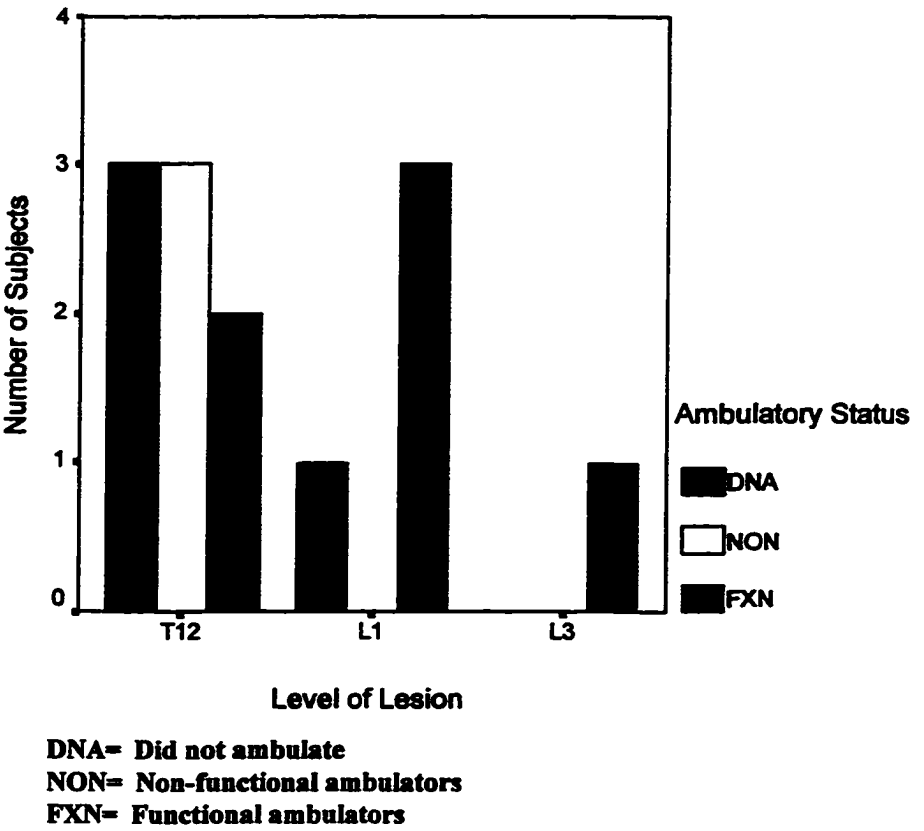



**Figure 1. Relationship Between Ambulatory Status and Level of Lesion**

## FIM Scores

Functional Independence Measure scores were based on five categories: transfers (bed, chair, and wheelchair); car transfers; locomotion (walking); locomotion (wheelchair); and stairs. The total possible FIM score for these categories was 35. Tables 7 and 8 list the values of each subject's individual admission and discharge FIM scores, respectively. This information was utilized for further data analysis to determine the relationship between FIM scores and ambulatory status.

**Table 7**

**Rehabilitation Institute of Michigan Functional Independence Measure Admission Scores**

| FIM Scores: Admission | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transfers: (Bed, chair, w/c) | 6 | N/A | N/A | 3 | 4 | 4 | 5 | 5 | 3 | 3 | 4 | 4 | 2 |
| Transfers: Car | 6 | N/A | N/A | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Locomotion: Walk | 1 | N/A | N/A | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| W/C | 6 | N/A | N/A | 5 | 6 | 5 | 5 | 6 | 5 | 5 | 5 | 5 | 6 |
| Stairs | 1 | N/A | N/A | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total FIM Score | 20 | N/A | N/A | 11 | 13 | 12 | 13 | 14 | 11 | 11 | 12 | 12 | 11 |

**N/A= Information not available in chart**

**Table 8**

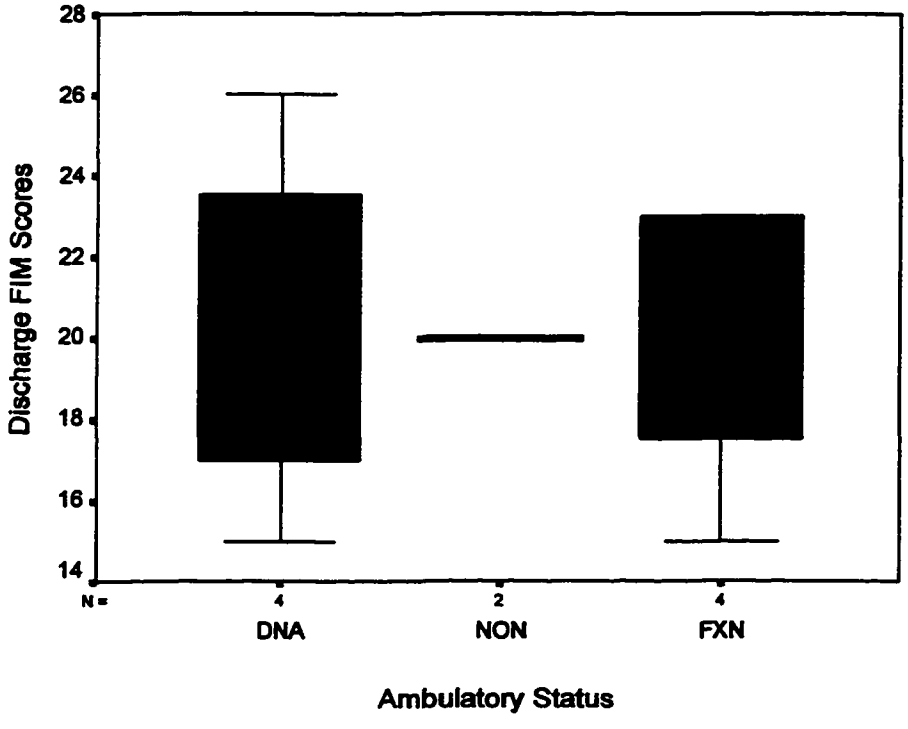
**Rehabilitation Institute of Michigan Functional Independence Measure Discharge Scores**

| FIM Scores: Discharge | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Transfers: (Bed, chair, w/c) | 7 | N/A | N/A | 6 | 7 | 7 | 6 | N/A | 6 | 6 | 7 | 7 | 4 |
| Transfers: Car | 6 | N/A | N/A | 5 | 7 | 5 | 1 | N/A | 6 | 5 | 5 | 1 | 3 |
| Locomotion: Walk | 1 | N/A | N/A | 1 | 1 | 1 | 1 | N/A | 1 | 1 | 1 | 4 | 1 |
| W/C | 7 | N/A | N/A | 6 | 6 | 6 | 6 | N/A | 6 | 6 | 6 | 6 | 6 |
| Stairs | 5 | N/A | N/A | 2 | 2 | 1 | 1 | N/A | 2 | 1 | 1 | 5 | 1 |
| Total FIM Score | 26 | N/A | N/A | 20 | 23 | 20 | 15 | N/A | 21 | 19 | 20 | 23 | 15 |

**N/A= Information not available in chart**

The subject's ambulatory status at the end of outpatient physical therapy was compared to their total discharge FIM score utilizing the Statistical Program for the Social Sciences (SPSS). Subjects who did not ambulate had discharge FIM scores that ranged between 15 and 26, with a mean score of 20. Non-functional ambulators had a mean discharge FIM score of 20. The range could not be determined secondary to the limited number of subjects in this category. Functional ambulators had discharge FIM

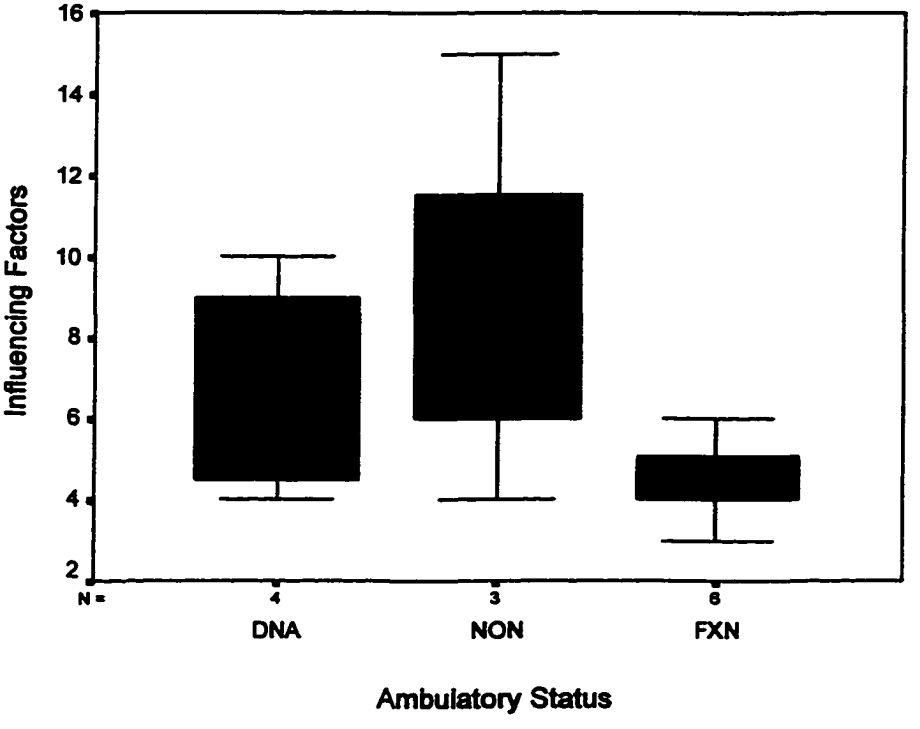
scores between 15 and 23, with a mean score of 21.5. Figure 2 represents the relationship between ambulatory status and total discharge FIM score. The box plot indicates the range of FIM score values that the subjects in each category attained. The shaded area of each box plot represents the range of FIM scores for the majority of the subjects. The dark line in the middle of each box indicates the mean of each sample in that category. The mean is computed by taking the sum of all values and dividing it by the number of observations in that category (Portney and Watkins, 1993).




**DNA= Did not ambulate**
**NON= Non-functional ambulators**
**FXN= Functional ambulators**

**Figure 2. Relationship Between Ambulatory Status and Total FIM Scores**

The subject's ambulatory status was also analyzed against their amount of influencing factors. Subjects who did not ambulate had a number of influencing factors that ranged from four to ten, with a mean of approximately six. Non-functional ambulators had a number of influencing factors that ranged from four to fifteen, with a mean of eight. Functional ambulators had the least amount of influencing factors which ranged from three to six. Figure 3 compares the relationship between ambulatory status and influencing factors in a box plot format which was previously described.




**DNA= Did not ambulate**
**NON= Non-functional ambulators**
**FXN= Functional ambulators**

**Figure 3. Relationship Between Ambulatory Status and Influencing Factors**

# CHAPTER FIVE

# DISCUSSION

The purpose of this study was to investigate whether utilization of the FIM would serve as a predictor of long term functional ambulation with long leg braces by individuals with a complete SCI at the level of T12-L3. Our primary aim was to determine if a relationship existed between total rehabilitation discharge FIM scores and long term functional ambulation with long leg braces of individuals with SCI. Our secondary aim was to incorporate the results of our data analysis into a chart format which health care professionals could utilize to predict long term functional ambulation in individuals with a SCI.

Based on the data collected, we were unable to determine that there is a relationship between total discharge FIM scores and long term functional ambulation in individuals with a SCI between the level of T12 and L3. Consequently, we were unable to devise a chart for health care professionals to utilize to predict long term functional ambulation in individuals with a SCI.

## Discussion of Findings

The expectation for this study was to analyze total discharge FIM scores and their relationship to long term functional ambulation. This was to be accomplished by recording individual total discharge FIM scores along with conducting follow-up phone interviews to determine subject's ambulatory status following discharge from outpatient physical therapy. The data collection process did not yield the information that we anticipated to collect. Therefore, we utilized descriptive statistics to analyze the information that we obtained from the chart review process.

The focus of this study was to collect total discharge FIM scores, however, RIM only documented FIM scores on five major categories. These categories included transfers (bed, chair, wheelchair), car transfers, wheelchair mobility, locomotion (walking), and stairs. Although the FIM score information that we obtained was related to mobility and locomotion which are the key aspects of our study, there are other areas of independence which the FIM measures. These are important areas which need to be considered, and therefore we cannot assume that portions of the FIM can be analyzed and extrapolated to represent the total FIM in relation to an individual's functional independence level. Consequently, this information did not adhere to the specifications of the inclusion criteria that we had established for recording total FIM scores; thus we did not follow up with phone interviews which would have provided us with information on whether or not the subject continued to ambulate following discharge from outpatient physical therapy.

The five FIM categories as recorded by RIM did allow us to attain FIM score data which could be analyzed. We utilized this information in conjunction with the subject's ambulatory status upon discharge from outpatient physical therapy to determine if there was a relationship between the two. The data revealed a mean total discharge FIM score for the functional ambulators to be 21.5 versus the other two groups, which had the same mean total discharge FIM score of 20.0. The subjects who did not ambulate had a total discharge FIM score ranging between 15 and 26, compared with the functional ambulation group which had a range between 15 and 23. This data shows that the subjects who did not ambulate had FIM scores that were comparable to those in the

functional ambulation group. Therefore, in our sample population discharge FIM scores we collected cannot predict functional ambulation.

The nature of the FIM and its scoring criteria is one explanation for our findings. The FIM is an objective tool that is not able to differentiate between one subject's overall independence as an ambulator with orthotic braces versus another subject's overall independence utilizing a wheelchair as their primary mode of mobility. Dodds et al., presented the results of their study in which the internal consistency of the locomotion portion of the FIM was only at an alpha level of .68 and the alpha level for the SCI population was only .41. Consequently, these findings indicate that the FIM is not necessarily sensitive to the specific differences in individuals as long as they are functionally independent.

A second problem with utilizing FIM score information during data collection is the potential for clinician interpretation to result in inaccurate scoring. For example, subject number one had discharge FIM scores in two of the five categories recorded as a seven. As stated in Appendix D, a score of seven indicates that the subject can ambulate a minimum of 150 feet without an assistive device...and does not use a wheelchair. This is an inappropriate score for the subjects in our sample population because the nature of their injury requires some form of assistance (wheelchair, long leg braces, assistive device, or transfer equipment). Therefore the highest score that these individuals are able to obtain would be a six, which as stated in Appendix D is modified independence. Thus, inaccurate FIM scoring can produce an inappropriate description of the patient presentation. These findings do not correlate with the study by Ottenbacher et al.,

because their results revealed that "the FIM provides good interrater reliability across a wide variety of raters" with a 95% confidence level.

Our data analysis revealed a basic relationship between ambuiatory status and the number of influencing factors for each subject. The subjects who were functional ambulators had between three and six influencing factors as opposed to those who did not ambulate and those who were non-functional ambuiators whose influencing factors ranged from four and ten, and four and fifteen, respectively. This is congruent with the findings of Rosman and Spira (1974), Coghlan et al. (1980), Mikelberg and Reid (1981), and Anson and Shephard (1996) who indicated that need, motivation, age, physical condition, financing, pain, obesity, spasticity and bladder problems affected the ambulatory status of their subjects. These findings are not congruent with the results of Hong et al. (1990), who revealed through statistical analysis that "discontinued usage of braces for ambulation was not related to ...marital status, educational level, living arrangements, or social activities; but was related to age, medical problems, and dependence for ADL..." These discrepancies could be attributed to the variability between individuals and how those factors effect each person, which could be a product of the sample population which is studied.

The above factors within our population were analyzed as though each influencing factor were comparable to the next. We recognize that these factors cannot be appropriately compared to determine the affect on ambulation, however we did not have a sample size large enough to allow us to break the influencing factors into categories which could be effectively statistically analyzed.

Several reasons account for our small sample size which include geographical location, the hospital database system, and the emergence of acute or subacute rehabilitation facilities. Our sample was a population of inner city males who acquired their injuries primarily from acts of violence. Therefore, this population may have had a greater number of associated factors (Table 4) that influenced their ambulatory status. These factors may not be represented in a population taken from a different geographical location. Second, the limited availability of subjects may have been related to the computerized hospital database from which our sample population was obtained. There have been many other individuals at RIM with SCI in the past, however, we were unable to access them because they were not entered in the database which only included patients from a limited number of years. Finally, individuals with lesions at a level T12 to L3 may not necessarily require the intensity and comprehensive nature that is provided by a rehabilitation hospital as compared to higher level paraplegics and quadriplegics which command this specialized care. An explanation for this could be that there has been an increase in the number of admitting hospitals with improved rehabilitation services which allows an individual with a SCI to be treated in the same facility in which they were initially admitted. Subsequently, there may be a trend of lower level paraplegics receiving physical therapy from an acute or subacute care hospital rather than from a rehabilitation hospital. Therefore, our sample population of 13 subjects was too small and narrow to generalize our findings to all individuals with a SCI.

Application to Clinical Practice

Throughout our data collection, we discovered that many patient charts were either missing FIM scores or had incomplete FIM scores. For example, subject eight,

Table 5 had admission FIM scores recorded in the chart. However, as seen in Table 6, the subject's discharge FIM scores were not recorded in the chart. Concurrently, there were inconsistencies in clinician interpretation of scoring criteria as previously mentioned. More accurate and consistent methods for recording and charting FIM scores is essential. This objective information is a critical component to objectively monitor patient functional status as well as to monitor outcomes for future professional growth and the justification for interventions.

Limitations

The researchers were unable to review a sample chart prior to solidifying the specifics of the study due to restrictions imposed on us by the Human Subjects Review Board Committee. This prevented us from establishing a research study that included realistic inclusion criteria based on the available data at the research sites. Subsequently, the inclusion criteria was based on the literature that we reviewed, therefore we focused the study specifically on FIM scores which were not easily attainable from the charts we reviewed.

The data collection required both researchers to participate in the process. Although the data collection sheets listed specific information to be collected, each researcher may have varied in how specific they recorded and/or interpreted the pertinent information. Therefore, there may have been discrepancies within each researcher's data recording. For example, numbers may have been transposed, or data may have been entered on the form incorrectly. These elements decrease the intra-tester and inter-tester reliability of our study.

Suggestions for Future Research

In the discussion, it was stated that the FIM alone cannot serve as a predictor of functional ambulation and that there are other factors which may influence individuals with a SCI. Therefore, we recommend a study which investigates the combination of FIM scores, influencing factors, and level of lesion and their predictive ability of functional ambulation status. The subject pool should be taken from a variety of geographic locations. The sample size should be large enough to categorize the various influencing factors to allow for specific conclusions to be made regarding which factors are more influential than other factors. The facilities utilized should be pre-screened for their FIM documentation protocol to control for consistency during the data collection process.

The researchers recommend a study which analyzes the long term outcomes of individuals with SCI. A survey could be utilized to evaluate post-discharge functional outcomes in the home and in the community.

Summary

The major finding of this study was that the sample population did not show a relationship between FIM scores and functional ambulation. The findings did show a basic relationship between influencing factors and functional ambulation. Therefore, the results did not support the hypothesis that there is a relationship between FIM scores and long term functional ambulation in individuals with SCI at the level of T12-L3. We were also unable to incorporate the results into a chart format for health care professionals to determine long term functional ambulation in individuals with a SCI. We acknowledge that it may not be possible to predict long term functional ambulation in individuals with

a SCI; there are too many factors such as level of lesion, secondary complications, socioeconomic and financial status, motivation, and geographical location that could contribute to the success or demise of an ambulation program.

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## APPENDIX A

Description of the Levels of Function and their Scores

INDEPENDENT: Another person is not required for the activity (No Helper).

Score of 7 (Complete Independence): All of the tasks described as making up the activity are typically performed safely, without modification, assistive devices, or aids, and within a reasonable amount of time.

Score of 6 (Modified Independence): One or more of the following may be true: the activity requires an assistive device; the activity takes more than reasonable time, or there are safety (risk) considerations.

DEPENDENT: Subject requires another person for either supervision or physical assistance in order for the activity to be performed, or it is not performed (Requires Helper).

Modified Dependence: The subject expends half (50%) or more of the effort. The levels of assistance required are:

Score of 5 (Supervision or Setup): Subject requires no more help than standby, cueing or coaxing, without physical contact, or, helper sets up needed items or applies orthosis.

Score of 4 (Minimal Contact Assistance): Subject requires no more help than touching, and expends 75% or more of the effort.

Score of 3 (Moderate Assistance): Subject requires more help than touching, or expends half (50%) or more (up to 75%) of the effort.

Complete Dependence: The subject expends less than half (less than 50%) of the effort. Maximal or total assistance is required, or the activity is not performed. The levels of assistance required are:

Score of 2 (Maximal Assistance): Subject expends less than 50% of the effort, but at least 25%.

Score of 1 (Total Assistance): Subject expends less than 25% of the effort.

(Uniform Data System for Medical Rehabilitation, 1993).

## APPENDIX B

Procedures for Scoring the Functional Independence Measure (FIM)

1. Admission data must be collected within 72 hours after admission.
2. Discharge data must be collected within 72 hours before discharge.
3. Follow-Up data are collected 80 to 180 days after discharge.
4. Record the score which best describes the subject's level of function for every FIM item.
5. Function is assessed by the clinician observing the patient directly. Actual performance, rather than capacity is recorded.
6. If differences in function occur in different environments or at different times of the day, record the lowest score. The usual reason for this is the subject has not mastered the function, is to tired, or is not motivated enough to perform the activity out of the therapy setting. There may be a need to resolve the question of what is "usual" by discussion among team members.
7. Setup is uniformly rated at level 5 for all items.
8. If the subject would be put at risk for injury if tested, enter 1.
9. If the subject does not perform the activity, enter 1.
10. When two helpers are required for the subject to perform activities described in an item, enter a score of 1.
11. Do not leave any FIM item blank.
12. Do not enter "N/A" for any item.

13. For the items walk/wheelchair, comprehension and expression, check the most usual mode in the small oval.

14. The mode of locomotion for item (walk/wheelchair) must be the same on admission and discharge. If the subject changes the mode of locomotion from admission to discharge (usually wheelchair to walking), record the admission mode and score based on the most frequent mode of locomotion at discharge.

(Uniform Data System for Medical Rehabilitation, 1993).

## APPENDIX C

Description of FIM Subsets and Individual Categories

Subset 1: Self Care Activities

A. Feeding
B. Grooming
C. Bathing
D. Dressing-Upper Body
E. Dressing-Lower Body
F. Toiletting

Subset 2: Sphincter Control

G. Bladder Management
H. Bowel Management

Subset 3: Mobility

Transfers:

I. Bed, Chair, Wheelchair
J. Toilet
K. Tub, Shower

Subset 4: Locomotion

L. Walking/Wheelchair
M. Stairs

Subset 5: Communication

N. Comprehension
O. Expression

Subset 6: Social Cognition

P. Social Interaction
Q. Problem Solving
R. Memory

## APPENDIX D

Description of Locomotion and Procedures for Scoring

Locomotion: Walk/Wheelchair

Includes walking, once in a standing position, or if using a wheelchair, once in a seated position, on a level surface. Performs safely. Check the most frequent mode of locomotion (walk/wheelchair). If both are used about equally, check both.

No Helper

Score of 7 (Complete Independence): Subject walks a minimum of 150 feet (50 meters), without assistive devices. Does not use a wheelchair. Performs safely.

Score of 6 (Modified Independence): Subject walks a minimum of 150 feet (50 meters), but uses a brace (orthosis) or prosthesis on leg, special adaptive shoes, cane, crutches, or walker; takes more than reasonable time or there are safety considerations.

Score of 5, exception (Household Ambulation): Subjects walks only short distances (a minimum of 50 feet or 17 meters) with or without a device. Takes more than reasonable time, or there are safety considerations, or operates a manual or motor wheelchair independently only short distances (a minimum of 50 feet or 17 meters).

Helper

Score of 5 (Supervision or Set-up): Subject needs only standby supervision, cueing, or coaxing to go a minimum of 150 feet (50 meters). If subject is not walking, requires standby supervision, cueing or coaxing to go a minimum of 150 feet (50m) in a wheelchair.

Score of 4 (Minimum Assistance): Subject performs 75% or more of locomotion effort to go a minimum of 150 feet (50 meters).

Score of 3 (Moderate Assistance): Subject performs 50% to 74% of locomotion effort to go a minimum of 150 feet (50 meters).

Score of 2 (Maximum Assistance): Subject performs 25% to 49% of locomotion effort to go a minimum of 50 feet (17 meters). Requires assistance of one person only.

Score of 1 (Total Assistance): Subject performs less than 25% of effort, or requires assistance of two people, or does not walk or wheel a minimum of 50 feet (17 meters).

Comment: If the subject requires an assistive device for locomotion: wheelchair, prosthesis, walker, cane, AFO, adapted shoe etc., the walk/wheelchair score can never be higher than level 6. The mode of locomotion (walk or wheelchair) must be the same on admission and discharge. If the subject changes mode of locomotion from admission to discharge (usually wheelchair to walking), record the admission mode and scores based on the more frequent mode of locomotion at discharge.

(Uniform Data System for Medical Rehabilitation, 1993).

## APPENDIX E

### Data Collection Form I

Subject Name:_____

Medical Record Number:_____

Date of Birth:_____

Gender: Male_____ Female_____

Level of lesion:_____

Date of Injury:_____

Influencing Factors:

_____

_____

_____

_____

Date long leg braces were issued:_____

_____

| Item | Admission | Discharge |
|---|---|---|
| Date | | |
| Total FIM Score | | |
| Ambulation Distance | | |

Ambulatory Status: Functional ambulator_____ Non-functional ambulator_____

Discharge Date From Outpatient Rehabilitation_____

## APPENDIX F

### Data Collection Form II

Subject Name:_____

Subject Phone Number:_____

Subject Address:_____

_____

Date of Birth:_____

Verbal/Written Consent (yes/no):_____

Continuation of Ambulation (yes/no):_____

Ambulation in Home or Community:_____

Frequency of Ambulation Per Week:_____

Amount of Assistance Required:_____

## APPENDIX G

### Data Collection Form III

Subject Name (if consent given):_____

Subject Address (if consent given):_____

Date of Birth:_____

Gender: Male_____ Female_____

Level of lesion:_____

Date of Injury:_____

Influencing Factors:

_____

_____

_____

_____

Date long leg braces were issued:_____

_____

| Item | Admission | Discharge |
|---|---|---|
| Date | | |
| Total FIM Score | | |
| Ambulation Distance | | |

Discharge Date From Outpatient Rehabilitation_____

Ambulatory Status: Functional ambulator_____ Non-functional ambulator_____

Continuation of Ambulation (yes/no):_____

Ambulation in Home and/or Community:_____

Frequency of Ambulation Per Week:_____

Amount of Assistance Required:_____

## APPENDIX H
## INFORMED CONSENT: OPTION I

Date:

Matthew T. Sherman, SPT
Karin M. Copenhaver, SPT
3118 Plaza Drive, Apt. C6
Grand Rapids, Michigan 49525

Subject Name:
Subject Address:

Re: Research Study Subject Participation

Dear_____:

We are senior graduate students in the physical therapy program at Grand Valley State University. We are conducting research through Mary Free Bed Hospital and Rehabilitation Center, Grand Rapids, Michigan/Rehabilitation Institute of Michigan, Detroit, Michigan regarding individuals with a spinal cord injury who learned to walk with long leg braces during their outpatient rehabilitation.

We are contacting you as a potential participant in our research study. Please review the enclosed information. If you do not wish to participate, please call Dr. Ellen Ballard, chair of Human Subjects Review and Ethics Committee at Mary Free Bed Hospital and Rehabilitation Center at (616) 242-9201 within ten days of receiving this letter, and you will not be contacted. If you are willing to be contacted by phone and asked a few questions, then please read and sign the enclosed form and return it in the self-addressed, stamped envelope.

If you have any questions or concerns regarding your rights as a participant, you may contact Dr. Ellen Ballard at the above number, or Professor Paul Huizenga, chair of Grand Valley State University Human Subjects Review Committee at (616) 895-2472.

Thank you for your consideration,

Karin M. Copenhaver, SPT
Matthew T. Sherman, SPT

## SUBJECT PARTICIPATION CONSENT FORM

**Title of Project:** Paraplegic Functional Ambulation with Long Leg Braces and Upper Extremity Support: Predicting Long Term Usage Patterns Utilizing the Functional Independence Measure
**Principal Investigators:** Karin M. Copenhaver, SPT and Matthew T. Sherman, SPT
**Mary Free Bed Hospital and Rehabilitation Center Contact:** Ellen M. Ballard, Ph.D., Chairperson, Human Subjects Review Committee (616) 242-9201).
**Grand Valley State University:** Professor Paul Huizenga, Chairperson, Human Subjects Review Committee (616) 895-2472.

The purpose of our research is to determine if the level of functional independence of a spinal cord injured individual during acute rehabilitation can serve as a predictor of their success with ambulation with long leg braces after they have been discharged from outpatient rehabilitation. The knowledge gained will help rehabilitation professionals in their decision making process regarding the appropriate treatment programs for individuals with a spinal cord injury.

You have been chosen as a potential participant in our study based on the following information:

1. You are an individual with a complete spinal cord injury between the level of T12 and L3.
2. You were between the age of 18 and 65 at the time of your injury.
3. You received outpatient physical therapy at which time you were trained to walk with long leg braces, and were still walking a certain distance at the time of your discharge from outpatient therapy.
4. It has been at least six months since you received outpatient therapy, but no longer than two years.

You have a right to understand the following information before you agree to participate in our study:

1. You will receive one phone call between January and March by which an interviewer will ask four simple questions: 1.) Are you still walking using your long leg braces 2.) Are you walking in your home and/or the community 3.) How often are you walking per week 4.) How much physical assistance do you require for successful walking. The interview should take no longer than five minutes.
2. It is not anticipated that this study will lead to any physical or emotional risk to yourself.

3. Only two researchers will have access to your name, phone number, and address for the purposes of the phone interview only. Once the relevant data has been obtained, it will be transferred to a final data form. Your name, phone number, and address will be destroyed, as it is no longer relevant information to the study. Subsequently, the information you provide will be anonymous and kept strictly confidential and will be used only for the purposes of data analysis of this particular study.
4. You may ask questions or discuss your participation in the study at any time by contacting Karin Copenhaver (616) 669-2912 or Matthew Sherman (616) 447-0738.
5. Your participation in this study is strictly voluntary. You may refuse to participate in the study or discontinue at any time without penalty.

"I have read and understand the above information provided in this consent form. I agree to participate in the study. I authorize the investigators to utilize the information that they obtain to add to the body of scientific literature. I understand that by signing the consent form I am not waiving any of my legal rights."

_____ _____

(Participant Signature) (Date)

_____ _____

(Witness) (Date)

_____I am interested in receiving a summary of the study results in April, 1999. I understand that the researchers would then have to retain my name and address until the summary materials are sent, at which point my name and address will be destroyed.

The best time to reach me by phone is:_____

## APPENDIX I

## INFORMED CONSENT: OPTION II
## VERBAL CONSENT BY PHONE

Hello, may I please speak with_____. Hello, _____ my name is Karin Copenhaver/Matthew Sherman. I am a senior graduate student in the physical therapy program at Grand Valley State University. You should have received a letter from me regarding a study that I am doing on individuals with a spinal cord injury. As you may recall, I am calling you to ask your permission to answer a few simple questions, which should take no longer than five minutes. Do I have your permission to proceed.

Before we begin, do you have any questions or concerns regarding the purpose of this study, why you were chosen for this study, or your rights as a participant.

*The title of our research is: Paraplegic Functional Ambulation with Long Leg Braces and Upper Extremity Support: Predicting Long Term Usage Patterns Utilizing the Functional Independence Measure. The purpose of our study is to determine if the functional status of an individual with a spinal cord injury during acute rehabilitation can serve as a predictor of their success with ambulation with long leg braces after they have been discharged from outpatient rehabilitation.*

*1. You are not obligated to agree to participate. Your participation is strictly voluntary, and you will not be penalized for withholding your consent.*
*2. The information gathered from you today will be used for the purposes of this research project only. Once the relevant data has been obtained, it will be transferred to a final data form. Your name, phone number, and address will be destroyed, as it is no longer relevant information to the study. Subsequently, the information you provide will be anonymous and kept strictly confidential.*
*3. You may withdraw your consent to participate at any time without penalty.*
*4. You are free to ask questions at any time, including after the conclusion of this interview. I would be more than happy to give you my phone number for you to contact me with any concerns regarding your participation in this study. The contact for Mary Free Bed Hospital and Rehabilitation Center: Ellen M. Ballard, Ph.D., Chairperson, Human Subject Review Committee (616) 242-9201.*
*5. By giving your consent, you are not waiving any of your legal rights.*
*6. If you wish, you may receive a summary of our results upon the conclusion of our research in April, 1999, in which case, we would need to retain you name, and home address.*

Confirmation of consent with verbal permission (yes/no)_____