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Analysis of the Relationship between Initial Neurological Status and Adaptation Following Traumatic Brain Injury

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ANALYSIS OF THE RELATIONSHIP BETWEEN

INITIAL NEUROLOGICAL STATUS AND ADAPTATION FOLLOWING

TRAUMATIC BRAIN INJURY

by

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ABSTRACT

ANALYSIS OF THE RELATIONSHIP BETWEEN

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Trauma is a major cause of death and disability in the United States. Approximately 4% of victims incur life-long debilitating alterations in physical and personal integrity. The purpose of this study was to determine the relationship between initial neurological status following traumatic brain injury and adaptation. The study used a retrospective single group repeated measures design. Subjects were patients admitted to an acute care rehabilitation program and completed inpatient and outpatient rehabilitation regimes (N=49). All had traumatic brain injuries with Glasgow Coma Scale Scores documented on admission to acute inpatient hospitalization. The Glasgow Coma Scale was used to assess initial neurological status; the Functional Assessment Measure for adaptation. Initial neurological status was significantly correlated with adaptation ($r=.52$, $p=.00$) at entry into inpatient rehabilitation program, but not at completion. Adaptation improved throughout rehabilitation, with significant improvement from time of inpatient rehabilitation admission and completion of outpatient rehabilitation.

DEDICATION

This thesis is dedicated to my husband, Hoyt, and our children Jessica and Michael. There are not words which adequately express my intense appreciation for your love and support throughout this process. Without this support, I would not have been able to be successful. I love you all very much.

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Table of Contents

List of Tables

TABLE

List of Appendices

CHAPTER 1

INTRODUCTION

Trauma is a major cause of death and disability in the United States. Multi-traumatic injuries generally involve some degree of brain injury (Frye. 1987). According to the Interagency Head Injury Task Force Report (1994) there are over 2 million traumatic brain injuries per year in the United States, with 25% severe enough to require hospitalization. Of those individuals who survive, 70,000 to 90,000 will endure life-long debilitating alterations in physical and personal integrity. The expense related to care of traumatic brain injury patients often is measured in physical, psychosocial, and financial terms. Persons who survive traumatic brain injuries often are left with significant residual physical impairments in functional abilities, communication and cognition, as well as difficulties with social interactions and emotional maladaptation (Coburn, 1992). The estimated financial expense of caring for individuals following traumatic brain injury was approximately $4.2 billion in 1980. This expense had risen to nearly $12.5 billion by 1990 and has continued to rise since that time (Coburn, 1992).

Patients survive despite severe disabilities, due to advances in medical life-lengthening and life-saving interventions (Sherburne, 1986). Health care professionals place great importance on the determination of prognosis of brain-injured patients. Sherburne (1986) acknowledged that health care professionals are obligated to accurately assess the adaptive and rehabilitative potential for these individuals. Accurate assessment contributes to the

determination of prognosis, which guides the expectations of patients and families regarding recovery and rehabilitation following traumatic brain injury (Sullivan, Schefft, Warm, & Dember, 1994). The medical literature is replete with studies that aim to predict adaptation following traumatic brain injury; however, little information exists in the nursing literature. Through years of research a relationship has been found between the Glasgow Coma Scale score, as an indicator of initial neurological status of brain-injured patients, and adaptation (Alexandre, Colombo, Nertempi, & Benedetti, 1983; Jennett & Bond, 1975; Jennett et al. 1979; Langfitt, 1978; Lanza et al. 1990; Lehmkuhl, Hall, Mann, & Gordon, 1993; Levati, Farina, Vecchi, Rossanda, & Marrubini, 1982; Papastrat, L. 1992; Sahgal & Heinemann, 1989; Veltman, VanDongen, Jones, Buechler, & Blostein, 1993; Young et al. 1981).

Problem Statement

Advances in medical technology have led to a rising survival rate among people who have experienced a traumatic brain injury (TBI). The use of the term "survival" makes determination of adaptation following traumatic brain injury more complex. According to Bell (1986), patients who survive a brain injury may remain in either temporary or permanent comatose states without the presence of many characteristics commonly used to define life. Analysis of survival alone is not sufficient to determine individual adaptation following traumatic brain injury.

Traumatic brain injury is a crisis that profoundly alters the lives of affected individuals and significant others. Advances in medical technology do not lead necessarily to total recovery and return to functional lives (Coburn, 1992). After the acute and usually life-threatening initial stage, the individual and family must adapt to the chronic disability that ensues

(Campbell, 1988; Coburn, 1992; Martin, 1994). Traumatic brain injury may result in disabilities that have potential to affect all aspects of the individual's and family's daily existence.

Research findings suggest that disabilities resulting from brain injuries often are more difficult to cope with for patients and significant others than any other disability (Martin, 1994). This is primarily related to the varying degrees of behavioral and cognitive deficits that frequently occur (Bond, 1975; Coburn, 1992; Martin, 1994; Oddy, Humphrey, & Uttley, 1978; Rosenbaum & Najenson, 1976). The implications for health care professionals in both acute care and rehabilitative institutional and community settings are numerous. Nurses caring for individuals in these settings are presented with a unique opportunity to positively influence individual and family adaptation following traumatic brain injury (Martin, 1994). A comprehensive understanding of the ramifications of brain injury and subsequent adaptation is of critical importance.

Traumatic brain injury assessments provide insight into structural functions of the brain and the resultant injuries (Sullivan et al. 1994). Assessment of initial neurological status following traumatic brain injury has been found to have strong predictive value in determining adaptation of brain-injured individuals. Sullivan et al. (1994) reported that assessments may be used to guide expectations for patients and families and to better prepare them for the upcoming rehabilitative process. Martin (1994) suggested that regardless of degree of disability, the person with a traumatic brain injury would never be the same. Following traumatic brain injury, the individual may have physical, psychosocial, behavioral and cognitive alterations in adaptation. According to Martin (1994), these alterations leave

the patient and families and/or significant others with a degree of loss without death. It is important to provide families and significant others with information regarding initial neurological status and its relationship with adaptation.

Purpose

The purpose of this study is to determine the relationship between initial neurological status following traumatic brain injury and adaptation. Measures of adaptation will be analyzed at three specific points in time along the rehabilitative continuum: 1) admission to an acute rehabilitation setting, 2) completion of acute inpatient rehabilitation and 3) completion of outpatient rehabilitation. The establishment of this relationship will highlight the importance of accurate and complete assessment and documentation of patient condition following traumatic brain injury.

Significance

The increased survival rate and severity of disabilities following traumatic brain injury has a profound social and financial impact on society as a whole (Coburn, 1992; Martin, 1994). In the nursing profession, assessment of adaptation focuses on alterations in the physical health status and behavioral processes of individual patients (Griffith-Kenney & Christensen, 1986). The focus of nursing assessments following traumatic brain injuries is multifaceted, dealing with not only the individual patient's adaptation, but its impact on significant others as well. Prediction of patient adaptation, using initial neurological assessment data, can assist in the identification of potential needs for individual patients and significant others (Coburn, 1992; Martin, 1994; Sullivan et al. 1994).

Significant others play an important role in the recovery and rehabilitative process of brain-injured individuals. The burden, stress, and life-style changes imposed upon the family when one of its members suffers a traumatic brain injury have been documented (Grinspun, 1987; Lovely, 1987; Marshall et al. 1988; Martin, 1994; Stavros, 1987). Information that prepares patients, families, and significant others for changes at the behavioral and cognitive levels seems to be critical in dealing with loss of particular individual functions. Livingston, Brooks, and Bond (1985) reported that relatives are frequently unaware that social and cognitive deficits improve more slowly than physical deficits. This fact also is supported by Martin (1994) who examined the responses of family members and significant others when confronted with physical, psychosocial, and cognitive alterations of those who experienced traumatic brain injury. Martin's (1994) findings supported the notion that an understanding of factors used to predict adaptation was helpful when guiding families and significant others through the recovery process. Research in the past years also supports the idea that families of individuals following traumatic brain injury experience high levels of subjective burden and associated psychological distress (Brooks, 1991; Lewin, Marshall, & Roberts, 1979; and Rosenbaum & Najensen, 1976). Physical, psychosocial, and cognitive effects following traumatic brain injury, combined with the long recovery process, add to the burden placed on families and significant others. There is no doubt that families and significant others suffer as much, if not more, than the injured themselves.

CHAPTER 2

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Literature Review

The review of the literature included studies that relate to traumatic brain injury and the adaptation that occurs in the ensuing months and years. In addition, factors that affect initial neurological status, as well as adaptation, were reviewed.

Traumatic brain injury results from a physical insult to the brain that has the potential of leaving the patient with various degrees of physical, psychosocial, behavioral and cognitive capabilities. Disruption of the structural integrity of the brain causes decreased neurological functioning. Brain-injured patients often are defined by the presence of altered levels of consciousness, with the severity of injury being ranked from mild to severe (Lehmkuhl et al., 1993).

Traumatic brain-injured patients generally proceed through three stages: (a) acute care, (b) acute rehabilitation, and (c) long-term rehabilitation (Grinspun, 1987). The major goal for individuals in the acute-care stage is to save the patient's life and stabilize the medical condition (Grinspun, 1987; Lovely, 1987). Once the patient enters the acute rehabilitation stage the focus changes to assisting the individual to attain an optimal level of adaptation. The long-term rehabilitation focus is active, dynamic, and may continue for several years, although most significant

changes in adaptation take place in the initial stages following injury (Grinspun, 1987; Spivack, Spettell, Ellis & Ross, 1992).

Ninety percent of brain-injured patients will obtain their maximal level of adaptation within 6 months after injury (Grinspun, 1987; Jennett et al., 1977; Lovely, 1987). This finding may suggest that most patients who survive the initial acute stage following traumatic brain injury will become candidates for long-term physical and cognitive rehabilitation. The finding also suggests that for patients whose level of adaptation is severely compromised, maintenance of the current status may be the ultimate goal.

Initial Neurological Status

Brain-injured individuals present with altered levels of neurological functioning. A key component of physical assessment of neurological functioning is the Glasgow Coma Scale (GCS) (Hilton, 1991; Jennett & Teasdale, 1974; Jones, 1979; Marshall, Marshall, Vos, & Chesnut, 1990; Ross, Pitts & Kobayashi, 1992). The Glasgow Coma Scale provides a common language that facilitates comparison by health care providers who assess neurological functioning. The simplicity of the scale prevents the use of ambiguous terms such as stuporous and somnolent (Mason, 1989). By using the Glasgow Coma Scale, health care providers can easily record impairment of consciousness by assessing motor, verbal and eye opening responses of neurologically impaired individuals. The overall summed GCS score ranges from 3 to 15 (Hilton, 1991; Jennett & Teasdale, 1974).

The GCS score commonly is used to grade the severity of brain injury. The GCS indirectly measures the extent of brain injury, a major determinant of outcome, whether sustained in the initial injury or as a result of a secondary insult (Luhmkuhl et al., 1993). A GCS score of 15 (highest) reflects little or no

identifiable neurological impairment. A score of 3 (lowest) reflects severe central nervous system processing deficits. The central nervous system is not able to process simple basic reflex or voluntary motor activities (Lehmkuhl et al., 1993). Individuals who present with Glasgow Coma Scale scores of 3 to 8 are diagnosed as severe brain injury, 9 to 12 as moderate, and 13 to 15 as mild (Crosby & Parsons, 1989; Lehmkuhl et al., 1993).

<u>Factors that affect initial neurological status</u>. Alcohol contributes greatly to the prevalence of motor vehicle accidents, domestic accidents, and assault (Kerr, Kay, & Lassman, 1971; Sommers, 1994; Stewart-Amidei, 1987). The physiological effect of alcohol on the brain has special significance when assessing individuals with traumatic brain injury (Sparadeo & Gill, 1989; Sommers, 1994; Stewart-Amidei, 1987). Findings vary from study to study, but generally indicate that over half of all people who incur traumatic brain injuries have been consuming alcohol (Cooper, 1982; Sparadeo & Gill, 1989; Stewart-Amidei, 1987). According to Cooper (1982), alcohol-related accidents are more common in males than females, with males generally having higher blood alcohol levels than females. Cooper reported that, although it is difficult to determine statistically, traumatic brain injury is the most common alcohol-related injury.

Individual blood alcohol levels have been found to have an effect on initial neurological status of traumatic brain-injured patients (Cooper, 1982; Jagger, Fife, Vernberg & Jane, 1984; Sommers, 1994; Sparaedo & Gill, 1989; Stewart-Amidei, 1987). There is a great deal of similarity between the presenting symptoms of acute alcohol intoxication and those of brain injury (Sommers, 1994). Both alcohol and brain injury can contribute to alterations in level of consciousness (Stewart-Amidei, 1987). Blood alcohol levels of 0.15

to 0.39 can produce impairment of physical and mental functions. At blood alcohol levels of 0.40 or higher, decreased levels of cognitive functioning, with inability to control physical and behavioral activity, may be present (Stewart-Amidei, 1987). These findings, commonly present in individuals with alcohol-induced impairment, contribute greatly to the difficulty with which accurate neurological assessments are made.

Sommers (1994) noted that intoxicated individuals behave very much like patients with traumatic brain injuries. This makes accurate identification of a differential diagnosis more difficult. Symptoms such as respiratory depression, lethargy, agitation, confusion, and disorientation may be due to trauma, intoxication, or a combination of both. Certain neurological changes that are more likely to be caused by injury than alcohol intoxication are unequal pupils, inequality of strength and motion of extremities, and sudden changes in level of consciousness (Sommers, 1994).

Sparadeo and Gill (1989) found that individuals (N = 102) who had used alcohol at the time of brain injury had longer periods of physical agitation ($p < .002$), longer length of stay in trauma centers ($p < .02$), and lower global cognitive status at time of discharge from the acute care setting ($p < .002$). The findings may support the belief that individuals with positive blood alcohol levels have slower recoveries and possibly higher mortality rates at greater overall costs.

Jagger et al. (1984) examined the extent to which alcohol altered the initial determination of the Glasgow Coma Scale score in brain-injured adults (N = 257). The GCS score was used to measure initial neurological status of trauma patients on arrival to the emergency department and 6 to 10 hours later. Findings indicated that alcohol lowers overall GCS scores in brain-

injured patients. This effect was most pronounced among patients with a blood alcohol level of 0.20 or higher. The GCS improved between the first and second assessment in 30% of patients whose initial blood alcohol levels (BAL) was 0.20% or higher, and 16% for those with a BAL of < 0.20% ($p = .01$). The improvement in GCS scores in these patients seemed to be attributable to decreases in blood alcohol levels over time. These findings suggested that GCS scores obtained at least 6 hours after initial examination are more accurate indicators of neurological status in patients with high blood alcohol levels (0.20 or higher) than are scores obtained when initially assessed in the emergency care center.

The relationship between mortality following traumatic brain injury, age, and initial neurological status in relation to adaptation has been studied. Levati et al. (1982) conducted a retrospective record review of patients with severe traumatic brain injury ($\underline{N} = 215$). A statistically significant ($p < .001$) inverse relationship was found to exist between age and initial neurological status with mortality. That is, older patients with lower GCS scores had greater mortality rates. Among survivors, there was not a significant relationship between age and initial GCS score or overall level of adaptation.

Adaptation Following Traumatic Brain Injury

A relationship between initial neurological status, measured by the Glasgow Coma Scale score, and adaptation has been established. The Glasgow Coma Scale score has been found to be a good predictor of overall morbidity and adaptation of brain-injured patients (Nikas, 1987; Young et al. 1981). Morbidity rates of patients with a GCS score of 8 or less has been reported at 34% to 50%; with rates between 40% and 46% for individuals with GCS scores of 7 or less (Nikas, 1987). Upon further analysis of the data, Nikas determined

that individuals with GCS scores of less than 5 had mortality rates of 53 to 62% versus 18 to 20% in patients with GCS scores of 6 to 8.

Several scales have been developed to document adaptation following traumatic brain injury. These include the Glasgow Outcome Scale (Jennett & Bond, 1975), the Disability Rating Scale (DRS) (Hall, Cope & Rappaport, 1985; Rappaport, Hall & Hopkins et al. 1982), the Rancho Los Amigos Scale of Cognitive Levels and Expected Behavior (Hagen, 1982), the Functional Independence Measure (FIM) and its successor, the Functional Assessment Measure (FAM) (Granger, Hamilton, Keith et al., 1986; Keith, Granger, Hamilton & Sherwin, 1987; Uniform Data Set for Medical Rehabilitation, 1990).

The Functional Independence Measure (FIM) was developed for the purpose of providing an appropriate rating scale which would permit rehabilitation clinicians to assess severity of disability in a uniform and reliable manner. The 18-item instrument assesses self-care, sphincter management, mobility, locomotion, communication, and social cognition on a seven-level scale (Keith et al., 1987).

In a study by Disler, Roy and Smith (1993) the FIM was used as a measure of disability for neurologically disabled individuals to determine its predictive abilities in relation to hours of rehabilitative care needed to cope with individual daily living needs ($\underline{N}$ = 75). FIM scores were compared with the hours of care needed. In the study, one observer assessed the FIM scales while another estimated the hours of care needed. Initial findings showed a statistically significant relationship, although lower than initially anticipated ($R^2 = .39$, $\underline{p} < .001$). The variation in anticipated significance was found to be related to three extreme values. After correction for the extreme values, the Pearson correlation was .76 ($\underline{p} < .01$) (Disler, Roy & Smith, 1993). Simple

regression equations were calculated for the time of care required. When all 75 subjects were included, a one point change in FIM score altered the time of care by 4.1 minutes/day.

In studies relevant to traumatic brain injury patients, the FIM has been used as a measure of functional outcome. DiScala, Grant, Brooke and Gans (1992) focused on the assessment of disability of 598 children between the ages of 8 and 19 years. The study was designed to evaluate the relationship between clinician judgment, severity of injury and resulting disabilities. The consistency between the clinical judgment and the FIM score was explored. Disability was measured at discharge from acute care. The FIM total score and six subscales discriminated between three groups of patients with differing severity of injury as measured by the GCS and the Injury of Severity Score, number of impaired functions, discharge location (home, rehabilitation, extended care or other), and clinical prediction of duration of disabilities. Three levels of severity of neurologic impact were considered for the GCS: mild (GCS 13-15); moderate (GCS 9-12) and severe (GCS 3-8). The children were grouped according to the clinically predicted length of recovery: (a) $\leq$7 mo., N = 463; (b) 7-24 mo., N = 66; and (c) > 2 yrs., N = 69. All groups were homogenous in relation to age ($p > .05$), and gender distribution ($p > .05$). The three groups however, were significantly different ($p < .01$) in terms of severity of injury to the central nervous system and the autonomic systems. The FIM total scores were significantly different ($p < .01$) among the groups with average values of 110 in Group A, 80 in Group B, and 58 in Group C. The three groups were also significantly different in achievement measured by the six FIM subscales ($p < 0.01$) (DiScala et al., 1992).

The Functional Assessment Measure (FAM) was specifically developed for use with the brain-injured population, expanding on the FIM. It consists of the original 18 items on the FIM and an additional 12 items. The twelve items added to the FIM focus on cognition, psychosocial adjustment, and communication aspects of function believed to be especially relevant for brain-injured individuals (Hall, 1992). Each item is scored on a scale of 1 to 7, with a score of 7 indicating complete independence. The lowest possible total score, indicating the most severely disabled individual, would have an overall score of 30. Conversely, the highest possible total score, indicating the least disabled individual, would have an overall score of 210.

The FAM items were developed by clinicians representing each of the disciplines in a rehabilitation model system (Hall, Hamilton, Gordon & Zasler, 1993). The model systems database, from which the cases were extracted, totaled 332 cases. Approximately 78% were male; mean age was 34.5 years, mean time from injury to rehabilitation discharge was 77 days with 48 days mean rehabilitation stay. Eighty-one percent were discharged home or back into the community and 6.6% to long-term care. Severity indicators were collected and analyzed. The mean GCS score was 8.2; length of coma 7.9 days, and length of post-traumatic amnesia 36.2 days.

Relationship of Non-Treatment Factors to Adaptation

In 1984, Lokkenberg and Grimes evaluated the impact of non-treatment factors on adaptation of severely braininjured trauma patients (N = 254). The study identified six non-treatment factors as having some relationship to adaptation following severe brain injury. These non-treatment factors included: time of arrival to the emergency room, time of intubation, mode of transport (ground versus air), type of head injury, age of the patient, and

severity of brain injury. Adaptation was defined by the Glasgow Outcome Scale (GOS). The principle findings were: (a) Severity of brain injury (as measured by the GCS) demonstrated the greatest significance in predicting adaptation ($\underline{R}^2$ = .27, p < .000), and 2) patient age, between 15 and 64 years, was determined to have a significant relationship to adaptation ($\underline{R}^2$ = .02, p < .001). Two observations were pertinent within the study with regard to severity of injury, age, and adaptation. The first was that age influenced adaptation only when the older age group of 55 - 64 years was included. Also, age tended to exert an influence only when the injury was less severe (GCS scores of six to eight) (chi square = 11.95, df = 1, $\underline{p}$ < .000). With more severe injuries (GCS of three through five), age had no apparent influence on eventual adaptation (chi square = 1.94, df = 1, $\underline{p}$ <.17).

Summary

Two factors have been found to be beneficial in the determination of adaptation of brain-injured patients. These factors are initial neurological injury (as determined by the Glasgow Coma Scale score) and age. The Glasgow Coma Scale provides a quick and concise method of assessing and communicating neurological status of neurologically impaired patients. The FAM provides health care providers, patients, and families with a clear measure of the individual's functional rehabilitative ability, while emphasizing the critical components of cognition, psychosocial adjustment, and communication which often are hard to capture with other commonly used rating scales (Hall, 1992). When used in conjunction, the two instruments (GCS and FAM) provide an excellent means of conveying information about the relationship between the initial severity of traumatic brain injury and the individual's adaptation.

Conceptual Framework

Myra Levine's (1967) Conservation Model was used to conceptualize this study. Levine's work reflects an integration of the basic sciences with her beliefs about person and nursing. Her work is directed toward patients and their interactions with both the internal and external environments. These interactions require multiple adaptations to environmental change.

The Conservation Model focuses on the individuality of each person. Each person is viewed as a holistic being, comprised of several subsystems. Individuals maintain their integrity by a series of continual adaptations to changes within the internal and external environments. Levine (1990) views the entire life process as a process of adaptation. Levine views human beings as ". . .sentient, thinking, future-oriented and past-aware individuals. . . " (Levine, 1990, p. 10). For the purpose of this study, person is viewed as the brain-injured patient.

Environment, according to the model is considered to be a continual energy form. The internal environment consists of the physical and physiologic functioning of the individual (Levine, 1990). Each individual has a unique internal environment which is susceptible to constant change. This state of stabilized flow (homeorhesis) depends on negative feedback and autoregulation (Levine, 1973; Levine, 1990).

According to Levine (1967) there are several types of internal environmental responses for each individual. These include responses to fear and stress, inflammatory responses, and perceptual responses. Response to fear includes the activation of the sympatho-adrenal system. Response to stress represents a long-term reaction by the individual to the daily activities

of life and the total patient experience. Inflammatory responses are directed toward the removal of intruding irritants or pathogens, and finally, the perceptual responses integrate information from the external environment, including the basic orienting, visual, auditory, tactile, and taste-smell systems (Levine, 1967). The internal environmental responses of interest in this study of brain-injured patients are those which impact overall adaptive potential. All internal environmental responses pose potential threats to attainment of physiological and psychosocial health following traumatic brain injury.

The external environment encompasses perceptual, operational, and conceptual stimuli (Levine, 1967). Levine views the perceptual environment as that part of the environment which the individual responds to with the sense organs. The operational environment is that which the individual does not directly perceive, such as radiation, microorganisms, and pollutants. Finally, the conceptual environment is comprised of the languages, ideas, symbols, concepts and inventions (Levine, 1967; Levine, 1973; Levine, 1990). The external environmental responses of interest in this study of brain-injured patients are those which interfere with the individual's ability to interact with the environment following brain injury, particularly during a rehabilitative program.

Alterations in the internal environment can lead to an inability to respond to the external environment. All adaptation represents the relationship between the individual's internal and external environments.

Adaptation, or health, is the way in which personal and environmental circumstances become congruent over a period of time. It is the fit of the person in the adjustment with the "predicament of time and space" (Levine, 1990, p. 9). Levine (1990) defined adaptation as a continuum. Successful

adaptation requires that all conservation principles be in a state of equilibrium. When a disruption occurs which effects conservation of one of the principles, a resultant disturbance in subsequent areas ensues. Adaptation is viewed as being a matter of degree, not an all-or-nothing process. This is evident within the brain-injured population. There are commonly noted wide variations in adaptation throughout the post-injury period. These adaptations vary considerably in their quality, with each person possessing a unique adaptive capability. Adaptation is dependent on how the individual interacts with the environment. Levine focuses on adaptation, or health, as the process by which individuals maintain their wholeness or integrity. Therefore, the model emphasizes the effectiveness of the person's adaptation.

Within the Conservation Model, the measure of effective adaptation is compatibility with life. A poor adaptation may threaten life itself. At the same time, the degree of adaptive potential available to the individual may be sufficient to maintain life at a different level of effectiveness than previously held. All processes of living are adaptive processes. Survival depends on the quality of the adaptation possible for the individual (Levine, 1973; Levine, 1990). The brain-injured patient progresses through various levels of adaptation throughout the rehabilitative regime. Assessment of the adaptation at various points in time, provides information regarding progression towards optimal adaptive potential. In this study, the FAM measures adaptation at three points in time during rehabilitation.

According to Levine's model, nursing care is considered to be either therapeutic or supportive in nature (Levine, 1990). When nursing interventions are developed to influence adaptation favorably the nurse is acting in a therapeutic sense. However, when nursing interventions cannot

alter the course of adaptation to disease or illness, but can only hope to maintain the current state of health or fail to prevent further deterioration, the nurse is acting in a supportive nature (Levine, 1990). These therapeutic and supportive interventions are not only aimed at the patient, but at the family and significant others as well.

The ultimate aim of all nursing care activities, whether therapeutic or supportive in nature, is the conservation or preservation of patient energy and structural, personal, and social integrity when dealing with alterations in health state (Levine, 1990). According to Levine, this conservation takes place within a space-time continuum. When planning nursing care, the nurse must allow for progress and change and project into the future the patient's response to that treatment (Levine, 1967). The ultimate goal of all nursing care activities is to foster successful adaptation. Nursing care activities promote the conservation of the individual's integrity to ensure health, and, therefore, provide the strength to confront any residual disabilities (Levine, 1990).

The Conservation Principles

Levine's Conservation Model defines four basic principles which identify the way in which the individual's health is preserved. The conservation principles act as guidelines for nursing interventions. These principles are conservation of energy, conservation of structural integrity, conservation of personal integrity, and conservation of social integrity.

Conservation of Energy. The principle of Conservation of Energy is predicated on the need to balance energy resources against energy demands (Levine, 1990). In the provision of nursing care, whether therapeutic or supportive in nature, the nurse uses patient rate of energy consumption as a

means of measuring activity tolerance. Levine views disease processes of every kind as creating revisions in the energy exchange for the individual. The response to the disease demands on the resources which the individual possesses, weighed against individual physiological demands, affects the overall adaptive ability. Assisting the patient in energy conservation is a vital link in the natural defense system.

Chronic disease represents an alteration in the individual's ability to adapt to internal and external environmental challenges. These alterations involve a realignment of the energy resources available to the individual. Chronic diseases of all types, including traumatic brain injury, are followed by periods of relearning and readjustment. There must be a successful adaptation to the alteration in the interaction with the internal and external environment. This response is highly individualized, and success, according to Levine (1967), is a matter of individual definition.

Common problems of energy conservation which are present for patients with traumatic brain injury are those that pose a threat to adequate supplies of oxygen and/or nutrients, as well as to those factors that increase or reduce energy utilization. For brain-injured patients such problems may affect self-care ability, mobility and locomotion, and more specifically may produce respiratory paralysis, inability to swallow, poor appetite, lethargy/coma, and seizures (Taylor, 1974).

Conservation of Structural Integrity. The focus of the principle of structural integrity is that of healing. The principle of structural integrity is based on the premise that the wholeness of the body be protected and that normal physiologic functions be maintained (Levine, 1967; Levine, 1990). Structural change results in functional alteration, and these

pathophysiological processes present threats to the maintenance of structural integrity. Healing processes are essentially predicated on the preservation of structure and the conservation of function (Levine, 1990). Traumatic brain injury results in neuronal pathway disorganization (Kater, 1989). Under normal, healthy conditions these pathways are structured in such a manner as to facilitate adaptation. Over a period of time, the brain can reorganize its neuronal pathways to regain some degree of adaptation. Although recovery is most rapid in the first 6 months following the injury, or alteration in structural integrity, significant recovery can continue beyond 1 year (Kater, 1989).

Factors related to conservation of structural integrity which are important in caring for patients with traumatic brain injury are those factors in the rehabilitative process that assist in the reorganization of neuronal pathways. These factors may include bowel and bladder management to help the brain-injured patient achieve a degree of sphincter control. Other factors include those related to communication and cognitive functioning (Taylor, 1974).

Conservation of Personal Integrity. Conservation of personal integrity reflects the need to maintain the patient as a knowing, functional individual, able to adapt in a unique way to the changing realities of life (Levine, 1990). Levine (1967) notes that "nurses need not be reminded that the body does not exist separately from the mind, emotions, and soul. Conservation of the patient's personal integrity is clearly a nursing responsibility" (pp. 53-54). Self-respect and self-identity are believed to be cornerstones to a sense of personal integrity. Injury threatens these cornerstones, and the threat is compounded by hospitalization. Several responses are inherent in the overall

disease process following traumatic brain injury. These may include alterations in self-identity and self-respect, that influence psychosocial adjustment (Taylor, 1974; Levine, 1990).

Conservation of Social Integrity. This concept relates to patients in their relationships with important others. Individuals often define themselves according to their personal sense of social worth. Social integrity is threatened if this sense of worth is disturbed. The ultimate goal of maintaining an individual's sense of social integrity is the eventual return to a productive or at least satisfying existence outside the hospital environment. The true meaning of an individual's humanity is the result of their dynamic relationship with other human beings. Injury and hospitalization can contribute to physical and emotional isolation, while the social needs of the patient continue to exist and must be met. The nurse's consideration for and interest in the patient's family members and significant others demonstrates consideration for the patient's social integrity, but also lays the groundwork for the transition of care into their hands (Levine, 1967).

The critical nature of the disease entity and the long-term course of many neurological conditions present problems related to the maintenance of social integrity. Relationships within family and community are endangered as neurological impairments continue. Problems such as withdrawal by family and significant others, and a lack of purpose within a social system are commonly encountered (Levine, 1990). The ultimate goal of all interactions with patients following traumatic brain injury is provision and enhancement of social support systems.

If all aspects of integrity are intact and functioning at optimal levels within the individual's external environment, the person will have a stable

internal environment. Altered levels of adaptation will occur when there is a disruption within any of the areas of integrity. The etiology of the altered adaptation may be related to either the internal or external environment. All areas are interrelated and influence adaptation following traumatic brain injury.

Traumatic brain injury results from a disruption of the individual's internal environment brought about by an event in the external environment. This disruption results in impairment of the structural, personal, and social integrity of the individual. This is exacerbated by an inability to balance the increased energy expenditures with available energy resources. As individuals attempt to maximize adaptation, they proceed through a series of stages of change which are directly related to the present state of homeostasis. It is through this series of change that the individual is able to achieve a degree of adaptation. Family members and significant others play an important role in assisting the patient in the process of adaptation following traumatic brain injuries. Health is achieved when the complex interactions and adaptation are successful, as determined by the individual patient (Levine, 1990).

Adaptation as a Reflection of Conservation Principles

Conceptualization of adaptation is a complex process and involves integration of physiological knowledge and knowledge of the conservation principles. Nursing activities to accurately assess physiological status, such as with the GCS, and its relationship to energy and structural, personal, and social integrity are critical. According to Levine's Conservation Model, when any one area of functioning is interrupted, as is the case of a patient with a traumatic brain injury, there will be an interruption in the individual's

wholeness or health. This interruption of wholeness manifests itself not only in the individual, but the family and significant others as well.

Adaptation following traumatic brain injury is dependent upon energy balance, and the degree of structural, personal, and social integrity attained. Individuals who have not adapted successfully to the brain injury may have disturbances in all areas. The degree of disability following brain injury is congruent with the severity of disruption within the areas of conservation. Indeed, individuals who have successfully adapted to brain injury and who present with minimal, if any, disabilities will have a high degree of stability and equilibrium within each principle area of conservation. It is the degree of stability or equilibrium within the system that determines the degree of adaptation which each individual following traumatic brain injury will attain.

When examining adaptation using the Functional Assessment Measure (FAM), various adaptive states can be identified. This tool is intended to include minimum numbers of items which may be used as basic indicators of severity of disability. Rehabilitative settings for traumatic brain-injured patients are designed to assist patients to attain maximal functioning in all of life's activities. The severity of disability changes during rehabilitation, therefore changes in the FAM scores are indicators of the benefits or outcomes of care. Assessment of progression throughout the rehabilitative program is a helpful aid to determining efficacy of the program. The FAM is intended to be a measure of disability, not impairment. Therefore, it measures what the individual is actually capable of doing. The 30-item Functional Assessment Measure yields a score that represents the patient's total ability or adaptation (Hall et al., 1993).

Theoretical Definitions

Initial Neurological Status

Initial neurological status will be defined as level of consciousness. Levels of consciousness rank from behavioral wakefulness with a capacity to respond appropriately to stimuli (fully conscious) to coma, which is complete unconsciousness (Miller & Keane, 1978). For this study, initial neurological status will be defined according to the GCS.

Adaptation

Adaptation following traumatic brain injury is theoretically defined as the physical, psychosocial, and cognitive functioning attained by the patient after injury. Adaptation consists of a balance between the internal and external environments. It embodies an interwoven mesh of variables related to energy, structural, personal and social factors. It is determined by the degree to which the individual is able to return to normal or near-normal pre-injury activities of daily living (Cope, Cole, Hall, & Barkans, 1991). For this study, adaptation will be defined according to the FAM score.

Hypothesis

There is limited research by nurses dealing with adaptation following traumatic brain injury. This study evaluated the relationship between initial neurological status and adaptation. The research hypothesis tested was: There is a relationship between initial neurological status following traumatic brain injury, measured by the Glasgow Coma Scale, and adaptation, measured by the Functional Assessment Measure, at time of admission to acute inpatient rehabilitation, discharge from acute inpatient rehabilitation, and discharge from outpatient rehabilitation. Additionally, a research question asked: Is

there a significant difference in adaptation following traumatic brain injury. measured by the Functional Assessment Measure, at time of admission to acute inpatient rehabilitation. discharge from acute inpatient rehabilitation, or discharge from outpatient rehabilitation.

CHAPTER 3

METHODOLOGY

This study used a retrospective repeated measures design with one group. The purpose of the study was to examine the relationship between initial neurological status and adaptation following traumatic brain injury on admission to acute inpatient rehabilitation, at completion of acute inpatient rehabilitation, and at completion of outpatient rehabilitation.

Sample

Subjects were all patients admitted to an 80-bed metropolitan rehabilitation hospital between April 1989 and December 1993 who met the study inclusion criteria. The inclusion criteria for subjects was (a) A traumatic brain injury assessed by the Glasgow Coma Scale and score documented during the first 24 hours following admission; (b) 18-50 years of age; (c) a blood alcohol level of less than 0.20% at time of admission to the acute care hospital following injury; and (d) history of participation in both inpatient and outpatient rehabilitation programs.

Identification of subjects was accomplished through a review of the outpatient clinical log and the medical records of patients entered into the hospital database. A total of 165 charts were reviewed retrospectively.

The outpatient clinical log consisted of all patients who participated in the outpatient program since its inception. The hospital database consisted of patients who had received both inpatient or outpatient rehabilitation following traumatic brain injury. Age and blood alcohol level may affect

adaptation following traumatic brain injury, therefore, these variables were controlled by criteria for inclusion in the study.

Instruments

Initial neurological status. Initial neurological status, a predictor variable, was operationally defined as depth of coma. Depth of coma was measured at the ordinal level by the Glasgow Coma Scale. The GCS was initially developed in 1974 by Jennett and Teasdale to standardize observations of depth of coma in patients with traumatic brain injuries. The GCS has been found to be a quick, accurate, and simple tool for evaluating neurological status in clinical practice (Jones, 1979).

The Glasgow Coma Scale is generally used to effectively describe the various states of impairment of consciousness. The GCS was developed to specifically address the three different aspects of behavioral response, specifically motor response, verbal response, and eye opening response (Jennett & Teasdale, 1974). The GCS assesses three parameters of depth of coma: (a) eye opening--with four grades ranging from spontaneous to none; (b) best verbal response--with five grades ranging from oriented to mute (or intubated); and (c) best motor response--with six grades ranging from obeying commands to no response (see Appendix A). A numerical score is given for the appropriate response in each of the three categories. The total of the three scores is the GCS score. The GCS score may range in value from 3 to 15, with 3 being the most severe and 15 being fully responsive and conscious (Marshall, Marshall, Vos, & Chesnut, 1990).

The Glasgow Coma Scale is a simple, clear tool that increases the consistency between observers in describing a patient's depth of coma. The

scale has generally well established validity and reliability (Jennett & Teasdale, 1974; Teasdale, Knill-Jones, & van der Sande, 1978; Jones, 1979).

Overall content validity of the GCS is well supported (Teasdale & Jennett, 1974; Langfitt, 1978; Jennett et al., 1979; Jones, 1979; Kater, 1989). Two main sources of observer variability, or inter-rater variability, have been identified: variations in the response given by the patient, either because the condition was fluctuating or because the examination had been conducted in a different way and variations in the interpretation of the same response by different observers (Teasdale, Knill-Jones, & van der Sande, 1978). Previous studies found that although different investigations of the GCS score demonstrated that the GCS is more reliable than some alternative instruments, there was, as with any method of clinical assessment, a degree of variability inherent in its use. To examine the reasons for this variability, Teasdale et al. (1978) determined a confidence interval with which the difference between two observers' findings may be taken to indicate an actual clinical difference rather than a reflection of inter-observer variability. The study found that there was a one in three chance that a change of only one in the coma scale total may be due merely to inter-observer variability. If the change in either direction was greater than one, it was almost 90% certain that this reflected an actual change or difference in the patient's condition. Moreover, the more profoundly consciousness was impaired (the lower the score), the more meaningful was an observed change. In this circumstance, the overall score depended mainly upon motor responsiveness, the most consistent of the three parameters of the scale (Teasdale, et al., 1978).

Reliability studies have shown that medical and nursing staff can evaluate patients with the GCS with very little inter-observer variability.

particularly when addressing the best motor response component of the instrument (Jones, 1979; Braakman, Avezaat, Maas, Poel, & Schouten, 1980). Braakman et al. (1980) studied the inter-observer agreement of the best motor response portion of the GCS. The authors studied the motor response component because it was found that motor response afforded the finest discrimination of depth of coma in patients with impairment of consciousness. A high rate of inter-observer agreement was found within the assessment of the motor response (Kappa = .56, $p \geq .88$). Because this study used archival data, inter-observer agreement on the GCS scores could not be verified or tested.

Adaptation following traumatic brain injury. Adaptation following traumatic brain injury, the criterion variable, will be operationally defined using the Functional Assessment Measure (FAM) The purpose of the functional assessment measurement tool is to provide a measure of disability that encompasses self-care, sphincter control, mobility, locomotion, communication, psychosocial adjustment, and cognitive functions of the patient (Hall et al., 1993). The FAM is an extension of the FIM.

The Functional Independence Measure (FIM) was developed by a national task force sponsored by the American Academy of Physical Medicine and Rehabilitation and the American Congress of Rehabilitation Medicine (Granger, Cotter, Hamilton, & Fiedler, 1993). The FIM is an 18-item, 7-level scale (see Appendix B). The development of the FIM was completed in three phases in hospitals: pilot (1984-1985), trial (1985-1986), and implementation (Hall, Hamilton, Gordon, & Zasler, 1993). The trial phase involved 25 facilities, 250 patients, and 891 clinicians (Hall et al., 1993).

The FIM was designed to assess varying areas of dysfunction in activities which, at personal levels, would commonly occur in patients with

progressive, reversible, or fixed neurological, musculoskeletal, or other disorders. The FIM was designed to assess levels of disability. The tool is relatively discipline-free, reliable, and simple to use. These characteristics enhance the ease with which patients can be assessed, in that it can be completed by many care providers and yet determine the disability of the individual in a fairly accurate manner.

The validity of the FIM has been established in a variety of ways (Adamovich, 1992; Hall et al., 1993). The FIM has been found to be a valid instrument to assess functional adaptation with patients who have experienced a traumatic brain injury. DiScala et al. (1992) found that in children 8-19 years of age, the FIM total score and six subscales discriminated significantly between three groups of patients with differing severity of injury. The severity of injury was assessed using the Glasgow Coma Scale and the Injury Severity Score.

Inter-rater agreement of the FIM has been reported by Hamilton, Laughlin, Granger, and Kayton (1991) to be high. The inter-rater correlation for the total FIM score of 263 inpatients assessed by pairs of clinicians at 21 hospitals was high (r^2 = .97) FIM sub-score inter-rater correlation ranged from .93 to .96 and FIM item scores had a mean Kappa value of .71 (range = .61 to .76).

The Functional Assessment Measure (FAM) was developed by the General Rehabilitation and Head Injury Program at Santa Clara Medical Center in San Jose, California. The main objective of the development of the FAM was to keep the measure simple while accurately assessing adaptation. The FAM was developed to extend the FIM by 12 additional items with greater specificity for the traumatic brain-injury population (see Appendix B). The 12 items are

intended to be added to the 18 items of the FIM. The FAM items emphasize the cognitive and psychosocial aspects of the disability (Hall et al., 1993). Many of the FAM items include greater measures of disability which may be more pertinent to follow-up periods in traumatic brain injury rehabilitation. Such items as community functioning, car transfers, employability, and community mobility, are critical to the effective adaptation of individuals following traumatic brain injury. The FAM is intended to be an evaluation tool designed to measure outcomes and not a refined clinical instrument (Hall et al., 1993).

The original FIM items (numbers 1-18) represent the individual's ability to maintain integrity within the areas of energy conservation and structural integrity. Higher scores in these areas would indicate a greater attainment of stability or adaptation within these areas (Byrnes & Powers, 1989). The remaining 12 items, representing the FAM, are geared more toward the areas of personal and social integrity. These items reflect the individual's ability to successfully maintain a degree of personal and social integrity, congruent with successful life adaptation. These 12 FAM items were specifically designed for individuals who have experienced a traumatic brain injury. They were added to the FIM to better capture the patient's overall adaptation primarily related to common problems encountered by patients following traumatic brain injury. Individuals who have high scores in this area have greater abilities to communicate, interact in social and emotional situations at a higher level, and have more defined cognitive functioning abilities. The new 30-item instrument is known as the FAM, or sometimes FIM/FAM. The goals for brain-injured patients are to gain the greatest level of functioning, as evidenced by high FAM scores during and following acute inpatient and outpatient rehabilitation.

Pilot work on the reliability testing of the 30-item FAM was completed at Santa Clara Valley Medical Center (Hall, 1992). Results of an item analysis of the FAM, when 20 observers provided separate ratings for several patients, revealed less than desirable inter-observer reliability (approximately 67%). The authors noted though that individuals who were assessing the FAM at time of study had not been formally trained in the FAM and therefore it was hypothesized that lack of specified training influenced the overall inter-observer reliability (Hall et al., 1993). Little work has been done to more accurately determine the overall reliability of the FAM rating for individual patients. This is an impediment to its ongoing use in the field for prediction of rehabilitative outcomes.

Currently, there are 12 individuals at the study rehabilitation setting who are credentialed as "reliable raters" by the Uniform Data System for Medical Rehabilitation, 1993. The individuals are from a wide range of disciplines, including registered nurses, speech therapists, occupational therapists, and physical therapists. Traumatic brain injury program managers at the facility have the responsibility for the accuracy of FAM data on an on-going basis. Individual department managers, via their clinical specialization, provide basic FAM training to new or reassigned staff members.

Admission ratings for the 30 items are established within 72 hours of admission by a multidisciplinary rehabilitative team. This is done for both the acute inpatient rehabilitation program and the outpatient rehabilitation program, and then every 14 days by those clinical disciplines assigned to rate each item. Each discipline identified on the data collection form (see Appendix B) scores its item(s). Ratings are designed to reflect actual observed performance, not the capability of the patients. Observations are discussed

within the multidisciplinary team meeting, and group consensus determines the actual score for each item. If particular activities are inappropriate or not assessed, the item is scored as a 1.0 (total assist or activity not performed). Discharge ratings for all items are established within 72 hours of discharge, preferably during the discharge conference. This is true for both inpatient and outpatient discharge ratings. Admission to acute care rehabilitation, discharge from acute care rehabilitation and discharge from outpatient rehabilitation FAM scores were extracted from the medical record by the investigator.

Procedure

A retrospective review of 165 medical records was completed by the investigator. The medical record review was conducted to retrieve GCS scores obtained within 24 hours of injury at the acute care hospital and FAM scores at admission to acute care rehabilitation, discharge from acute care rehabilitation, and discharge from outpatient rehabilitation. Demographic data included age, gender, and blood alcohol level at time of admission to acute care hospital. The sample size, after deletion of subjects for incomplete data sets was 49. Missing data from the original medical record review were primarily blood alcohol level and GCS score following injury.

CHAPTER 4

DATA ANALYSIS

The descriptive statistics and statistical tests of the hypotheses are reported in this chapter.

Descriptive Statistics

The sample consisted of 49 patients. Thirty-two patients (65.3%) were male; 17 (34.7%) were female. Twenty-nine (59.2%) of the 49 patients were injured in motor vehicle collisions and most had multiple fractures (51%) (see Table 1). The mean age of the sample was 27.04 (SD=8.9) (see Table 2).

Table 1

Background Characteristics of the Subjects (N=49)

Characteristic	n	(%)
Gender		
Male	32	(65.3)
Female	17	(34.7)
Cause of Injury		
Motor Vehicle Collision	29	(59.2)
Pedestrian	5	(10.2)
Bicycle	3	(6.1)
Motorcycle	3	(6.1)
Fall	3	(6.1)
Horse	3	(6.1)
Work Injury	2	(4.1)
Unknown	1	(2.0)
Presence of Multiple Fractures		
Yes	25	(51)
No	24	(49)

Means for admission blood alcohol levels, Glasgow Coma Scales (GCS), and Functional Assessment Measures (FAM) obtained at inpatient rehabilitation admission (FAM score T_1), acute inpatient rehabilitation discharge (FAM score T_2), and outpatient rehabilitation discharge (FAM score T_3) are displayed in Table 2. Also included are inpatient rehabilitation total

length of stay, and number of days from injury to acute inpatient rehabilitation admission.

Table 2

Means of Variables Describing the Sample (N=49)

Variables	Mean	(s.d.)	Range
Age	27.04	(8.94)	18-48 years
Blood Alcohol Level	.026	(.056)	.00-.19
GCS	8.44	(3.44)	3-15
FAM score T_1	95.89	(44.41)	30-184
FAM score T_2	173.5	(15.00)	136-208
FAM score T_3	195.04	(10.84)	162-218
Inpatient Rehab Total LOS	38.28	(25.75)	9-113 days
Number of days from injury to acute inpatient rehab	22.20	(18.29)	6-120 days

Test of the Research Hypothesis

The research hypothesis for this study posited a relationship between initial neurological status, measured by the Glasgow Coma Scale (GCS), and adaptation, measured by the Functional Assessment Measure (FAM). A statistically significant moderate relationship ($r=.52$, $p=.00$) was found between the GCS score and the FAM score obtained at time of admission to acute inpatient rehabilitation (T_1) (see Table 3). No statistically significant relationship was found between GCS score and the FAM scores obtained upon discharge from acute inpatient rehabilitation ($r=.04$), or discharge from outpatient rehabilitation ($r=.01$). A statistically significant moderate relationship ($r=.55$, $p=.00$) was found between the FAM score obtained upon discharge from acute inpatient rehabilitation (T_2) and the FAM score obtained upon discharge from outpatient rehabilitation (T_3).

Table 3

Correlation matrix of the relationships between Glasgow Coma Scale Score and Functional Assessment Measure Scores at three times during rehabilitation ($\underline{N}=49$)

	T_1	T_2	T_3
GCS	.52*	.04	.01
T_1		.19	.29
T_2			.55*

Note: T_1 = Admission to Acute Inpatient Rehabilitation
T_2 = Discharge from Acute Inpatient Rehabilitation
T_3 = Discharge from Outpatient Rehabilitation

*p<.00 for all comparisons

Test of the Research Question

Repeated measures analysis of variance (RM-ANOVA) measured the differences in FAM scores obtained at time of admission to acute inpatient rehabilitation (T_1), upon discharge from acute inpatient rehabilitation (T_2), and upon discharge from outpatient rehabilitation (T_3). Mauchly's test of sphericity tested whether use of a uni- or multi-variate approach to data analysis was appropriate (chi square = 68.33, df = 2). The statistically significant result (p=.00) indicates failure to meet the assumption; therefore a multivariate approach was used for analysis (Munro & Page, 1993). The time effect was statistically significant (F=190.70, p=.00), therefore, post hoc analysis was conducted. Paired t-tests compared differences between the three pairs of groups (see Table 4). The results indicate that there was significant improvement attained by the study subjects as they progressed through the rehabilitation regime.

Table 4

Paired Differences Between the Three Groups (N=49)

Time Comparison	t-value
$T_1 - T_2$	-12.35
$T_2 - T_3$	-11.71
$T_1 - T_3$	-16.3

Note: p=.00 for all t-values

CHAPTER 5

CONCLUSION

This chapter discusses the relationship of the sample characteristics to the literature, the findings and their relationship to the literature and the conceptual framework. Implications of the findings are discussed next. This chapter ends with limitations of the study and recommendations for future studies.

Relationship of the Sample Characteristics to the Literature

Assessment of adaptation following traumatic brain injury is a critical component of the ongoing care and rehabilitation of individuals who are recovering from this life-altering and potentially life-threatening disruption of integrity. By placing a focus on the preservation of health and wholeness within an individual, nurses can assist patients to attain the highest level of adaptation possible. Use of the conservation principles provides a guiding framework with which to focus the assistive efforts.

The sample characteristics in this study were consistent with that found in previous studies (Kerr, Kay & Lassman, 1971; Spettell, et al., 1991; Sommers, 1994). Sommers (1994) reported consistent findings regarding sample characteristics. She noted that young adults from ages 20 to 24 had the greatest proportion of drinking and driving, and young adults from age 15 to 24 were most likely to be involved in alcohol-related motor vehicle collisions. Spettell et al. (1991) found that the mean age of patients included in their study ($\underline{N}$ = 59) was 31 years of age at time of injury, with a range from 15 to 67 years.

In Hall, Hamilton, Gordon and Zasler (1993) the majority of study subjects were male with a mean age of 34.5 years versus 27.04 years in this study; mean GCS score was 8.2 versus 8.44 and total inpatient rehabilitation length of stay was 48 days as compared to 38.28 days in this study. It is difficult to determine the source of variation in length of stay between the two studies. It may represent variations in treatment modalities (inpatient versus outpatient), changes in health care delivery patterns for traumatic brain-injured patients, or may be related to the younger age of this study, although not seemingly a significant difference.

The majority of subjects within this study ($\underline{N}$=49) had severe brain injuries, as evidenced by GCS scores of 3-8 ($\underline{n}$=29). The remaining 20 patients in the sample had either a mild ($\underline{n}$=10) or a moderate ($\underline{n}$=10) brain injury. This is consistent with the study by Disler, Roy and Smith (1993). They noted that Functional Independence Measure (FIM) scores could be helpful in predicting the number of hours of care which would be required by individuals with disabilities ($r=-0.39$, $p < .001$). This finding supports the notion that individuals who do not have severe brain injuries, and extensive disruption of integrity would not require intensive acute inpatient rehabilitation and therefore would not have been included in the study.

Findings by Cooper (1982) and Stewart-Amidei, (1987) suggested that most traumatic brain injuries are the result of motor vehicle collision and a majority involved alcohol to some degree. In this study only 10 of the total 49 subjects had measurable alcohol levels reported in the medical record. The range of blood alcohol levels was 0.06 to 0.19. Thirty-nine of the 49 subjects had blood alcohol levels of zero (see Table 5).

Table 5

Range of Blood Alcohol Levels (N=49)

Blood Alcohol Level	n	%
.00	39	79.6
.06	1	2.0
.095	1	2.0
.107	1	2.0
.110	1	2.0
.111	1	2.0
.150	1	2.0
.153	1	2.0
.170	2	4.1
.190	1	2.0

Discussion of the Findings

The data in this study were used to analyze the relationship between initial neurological injury and adaptation following traumatic brain injury. It was thought that by attaining a better understanding of the factors which may influence adaptation, nurses could provide more complete, holistic care which focused on critical elements for a successful adaptation or outcome. The data did not support the overall hypothesis that initial neurological injury following traumatic brain injury, as measured by the Glasgow Coma Scale, had a significant positive relationship with adaptation, as measured by the Functional Assessment Measure (FAM). The data did support the hypothesis that initial neurological injury had a significant positive relationship with

adaptation at entry into an inpatient rehabilitation program (GCS and T_1). Initial neurological injury was not significantly correlated with completion of inpatient rehabilitation or discharge from outpatient rehabilitation (T_2 or T_3). However, a statistically significant relationship was found between FAM scores obtained upon discharge from acute inpatient rehabilitation and those obtained upon discharge from outpatient rehabilitation.

These findings suggest a "ceiling" effect produced by the rehabilitation program selection criteria. The rehabilitation hospital study site requires for admission to the acute program that patients possess adequate energy reserves and have the physical stability to participate in an aggressive physical rehabilitation regime. Participants must also have a strong social support system. Thus, patients with rapid improving GCS scores in the acute care setting become eligible for admission to the acute inpatient rehabilitation program. Individuals who are unable to sustain the rigors of such a program are excluded, and therefore would not have been included in this study.

The data demonstrated significant improvements in FAM scores throughout the rehabilitation regime, answering the research question regarding whether ongoing rehabilitation influences overall adaptation. This finding suggests that ongoing and progressive rehabilitation will positively influence adaptation, measured by the FAM, following traumatic brain injury.

<u>Relationship of the Findings to the Literature</u>

Literature supports that the "best" GCS score within the first 24 hours after injury is most predictive of adaptation 6 months after injury (Lehmkuhl et al., 1993; Nikas, 1987; Young et al., 1981). In this study, the GCS score which was used was the one recorded in the initial note by either the admitting acute

care physician or the intake coordinator of the rehabilitation program. It would be essential, therefore, to identify opportunities to more closely ascertain the "best" GCS score within the first 24 hours after injury. This may prove more appropriate in providing direction related to probable adaptation following traumatic brain injury. Individuals are chosen for success in the program, not only by the presence of strong physiological parameters but also based on strength of social support systems. Further correlational studies would be helpful in identifying key criteria for success within the program, and focusing efforts on assisting individuals to attain these criteria prior to entry into the rehabilitation program.

Findings from this study is consistent with the findings of Hall, Hamilton, Gordon and Zasler (1993), although a different measure of adaptation was used. There was significant improvement in the FAM scores for all study subjects whose GCS ranged from 3 to 15. The improvement may be related to a greater emphasis on and availability of intensive rehabilitative therapies in the community, selection of the sample from a rehabilitation institute (thereby preselecting for some level of success) or demonstration of strong supportive social support systems to facilitate ongoing improvement within the rehabilitation population.

Relationship to the Conceptual Framework

Adaptation within Levine's framework is defined as the way in which personal and environmental circumstances become congruent over a period of time. Success of adaptation requires a level of balance or homeostasis between individuals' energy reserves and their structural, social, and personal integrity. Ineffective adaptations may include alteration in the individual's pre-trauma level of effectiveness or death. Survival often is perceived as the

quality of the individual's adaptation. Adaptive changes occur over time, and ongoing therapeutic interventions assist to optimize the adaptive potential for each individual.

Traumatic brain injury results in disruption of the individual's internal environment, brought about from an event from the external environment. This impairs structural, personal, and social integrity, and is worsened by creation of an imbalance between energy expenditures and available resources. As the individual moves through the rehabilitative process, a level of equilibrium is attained which allows for maximal adaptation. Ability to fulfill self-care needs, sphincter control, mobility, and locomotion needs are integral to ongoing adaptation following traumatic brain injury.

Nursing care should be aimed at maximizing the adaptive potential for each individual. Intervention is directed at maintaining the current state of health or by preventing future deterioration. It is important to intervene with family members and significant others as well as patients when providing therapeutic and supportive interventions. The ultimate aim of all nursing care interventions is the conservation or preservation of patient energy, and structural, personal, and social integrity.

Cognitive function is a critical element to the overall maximization of adaptation following traumatic brain injury. Traumatic brain injury rehabilitation emphasizes interventions directed towards attainment of structural, personal and social integrity (e.g., physical strengthening, cognition, behavior, and social integration issues) and therefore is less amenable to study by accepted scientific methods (Hall & Cope, 1995). If the individual has the ability to care for self and can communicate with the external world, yet is unable to problem solve, remember important life events

or interact at an attentive and safe level with the external environment the adaptation will not be as fulfilling as one in which strong cognitive function returns. Care should be afforded, through use of supportive and therapeutic nursing interventions, to assist individuals to attain maximum levels of cognitive functioning through ongoing rehabilitation and "re-learning" of techniques to promote successful adaptation. Opportunities may exist for improvement in these areas as time progresses and refinement of rehabilitative processes occurs.

In the purest sense of the examination of adaptation, or outcomes, one must ask those who experienced the traumatic brain injury how successful they perceived their adaptation. Health is achieved when adaptation is successful in terms of energy balance, structural, personal, and social integrity. This, thereby, describes the complexity with which health care professionals are faced when identifying adaptation following injury and the degree of success which is attributed to the rehabilitation processes to which patients are exposed. Presumably, the more exposures an individual has, the greater his rehabilitative potential. This presumption is supported in this study by significant increases in functional adaptation (FAM scores) throughout rehabilitation. The greatest improvement occurred between admission to acute inpatient rehabilitation and discharge from acute inpatient rehabilitation. However, significant differences also were found for patients between discharge from acute inpatient rehabilitation and discharge from outpatient rehabilitation. This finding suggests that ongoing improvement is probable. Yet, this argument is difficult to make in that it is not conceivable that a "control group" be established to differentiate between those receiving rehabilitation and those who do not. Subsequently one must ask the question

"do the individuals improve purely on the basis of nature, or on the basis of how they are nurtured along in their rehabilitative process?"

Social integrity is influenced greatly by family and significant others. The involvement of family members and significant others is needed for refinement of integrity particularly within the area of social interactions. The FAM focuses activities on not only the comprehension and expression of communication items, but also reading, writing, and speech intelligibility. Psychosocial adjustment items, such as social interaction, emotional status, adjustment to limitations, and employability are also measured and inherent to successful adaptation.

Implications for Educative Nursing Interventions

Education in the area of adaptation following traumatic brain injury should focus on those aspects of care which will be supportive in nature of not only the brain-injured individual, but family members and significant others as well. There needs to be an improved understanding of the basis for outcomes based predictions, as well as how to assist individuals to attain maximal adaptation. Family and social support will be crucial to individual adaptation in that it will assist the individual to attain integrity within the personal and social realms. It also is imperative that care be taken to support the brain-injured individual into an "adaptive" versus "maladaptive" mode of coping with the rehabilitative needs which will be required to achieve maximal adaptation following the injury.

Implications for Administrative Practice

Administrators of health care and third-party payer organizations (such as insurance companies, Medicare/Medicaid) need to be aware of the potential which can be achieved by individuals following traumatic brain

injury. Findings from this study suggest that individuals continue to improve during the rehabilitative process and thereby realize improved adaptation at most levels. It is imperative that resources of time and finances be made available to support the rehabilitative process for traumatic brain injured patients.

Implications for Future Research

Future studies are needed to determine relationships between severity of injury and maximal level of adaptation, length of time to attain maximal level of adaptation, and the relationship between initial neurological status and maximal level of adaptation. The next question to ask would be at what severity of injury and what length of time for individuals to attain their maximal level of adaptation and is this influenced by their initial neurological status.

Areas for future research should focus on the aspects of nursing which have the capabilities to positively influence adaptation following traumatic brain injury. A greater understanding of the conservation of energy and maintenance of structural, personal, and social integrity will provide a strong framework for analysis. Analysis of sub-scale components of the Functional Assessment Measure (FAM) and analysis of the variance in sub-scale scores within the items would be helpful in identifying other aspects to study. A question to ask would be that of whether any one of the FAM items achieves greater importance or predictive ability when determining both actual and perceived adaptation following traumatic brain injury.

The variation between actual and perceived adaptation would be valuable in helping to identify whether there is success in the rehabilitative process as described by those who have been involved in it. What if the

individual, following traumatic brain injury rehabilitation, does not feel his/her adaptation has been successful. Are there elements of the rehabilitation process which could have been better focused or which would have aided overall adaptation following traumatic brain injury? Does the patient perceive that adaptation has been successful if he/she is unable to recover due to severe energy reserve disturbances or structural instability, yet is able to communicate effectively with the external world and interact at a strong psychosocial and cognitive level? Then too, how do families and significant others perceive the overall adaptation following traumatic brain injury rehabilitation? Are there areas that warrant greater emphasis? These are critical questions which nurse researchers could ask in the future.

Limitations to the Study

Several limitations to the study were identified. Use of archival data for the study is a limitation, in that there was an inability to assess the reliability of the GCS scores, as well as the FAM scores. Another was that of reliability of the initial GCS scores which were retrieved from the medical record review. There was no mechanism to assess the reliability of the individuals who recorded the initial information. The reliability of GCS assessment has been well established in previous studies, (Jennett & Teasdale, 1974; Teasdale, Knill-Jones & van der Sande, 1978; Jones, 1979).

The Functional Assessment Measure (FAM) data collection process may lend itself to some disagreement between observers. The use of a group consensus process in the study hospital to determine final FAM scores should ameliorate the inter-observer variability problem.

Another limitation to this study was the number of subjects who met the inclusion criteria and had complete sets of data. Although 169 medical records

were reviewed initially, only 49 had complete sets of data. A sample size of 30 would lend a medium effect size with α .05 (Stevens, 1996). The inclusion criterion primarily missing was blood alcohol level, followed by GCS score immediately following traumatic brain injury. Six of the original 169 subjects had blood alcohol levels in excess of 0.20 and therefore were excluded from the sample. This left approximately 124 subjects who may have been eligible for the study, but became ineligible due to lack of sufficient medical information. Generalizability would improve had the sample size been larger.

Another limitation to this study was the difficulty of identification of and subsequent medical record review of all patients who potentially met the inclusion criteria. The rehabilitation facility has several record maintenance systems which are maintained on a decentralized basis This made data collection more difficult and potentiated the probability for errors due to the inconsistent process.

Inconsistent process in the collection of pre-admission medical information made data collection difficult. Pre-admission medical information is collected individually by each person who is conducting the intake evaluation and is not consistent in regards to type of information collected. Moreover, there was no mechanism to identify the "best" GCS score within the first 24 hours after injury, thereby limiting the ability to be of use in predicting potential adaptation for individuals following traumatic brain injury. If this process was standardized among and within the acute care and rehabilitation institutions and departments the database would be more complete lending greater credibility to the information. Also, information could be retrieved more efficiently from the database than from the lengthy,

time-consuming, and problem-prone process of manual medical record review.

The findings of this study are not generalizable to other patient populations and really are of value to only the sample subjects. This is due primarily to lack of random sampling technique. The inclusion of participants from only one rehabilitation program also limits the generalizability. Moreover, the rehabilitation program used in this study preselects patients for admission based on their ability to succeed. This selection must be taken into account when interpreting the results of this study. Findings from this study do, however, provide insight into how patients may potentially progress through the rehabilitative process within the study community. Also, because the study was conducted in a natural setting, it may have meaning for similar patients in similar rehabilitative programs.

Recommendations for Future Studies

Recommendations for future studies focus on increasing control for the above noted limitations to the study. Reliability of individual assessment of GCS would improve the strength of accuracy of data relevant to assessment of impairment of neurological function following traumatic brain injury.

Functional Assessment Measure data collection is determined by a group consensus process. Ongoing assessment of reliability of scoring would be necessary to further document accuracy of scoring across a broad range of health care providers. The study site should, on a routine basis, assess reliability of the scoring using training vignettes which are provided by the original developers of the FAM.

Collection of pre-inpatient rehabilitation admission should be standardized. This pre-inpatient rehabilitation information should include all

available demographic information, as well as alcohol level, "best" GCS score within the first 24 hours after injury, length of coma, and computerized tomography (CT) scan results. It is recommended that a central computerized data base be established to afford ease of accessibility for a wide range of health care professionals. The information would be beneficial on not only a clinical level but also on a financial and utilization review basis.

It would be beneficial to broaden the scope of the study to other rehabilitation programs. Enlarging the study population to include all patients within the region who have a traumatic brain injury, and may be treated at other rehabilitation programs may be helpful. This would prevent the pre-selection of subjects based on their ability to participate in a vigorous rehabilitation program. This also may lend some credence to greater efficacy of some programs over others, thereby providing a base for selection of programs in which to participate.

Summary

Each year in the United States more than 100,000 Americans suffer from a traumatic brain injury. Most of these injuries are caused by motor vehicle collisions, with the majority involving young people who will soon be entering the prime of their lives (Strax, 1994). Traumatic brain injury is a tragedy not only for individuals, but to their families and significant others. It has the potential to destroy lives, shatter the family system and negatively impact the community.

As resources within the health care system become more scarce, questions will no doubt continue regarding the cost-effectiveness of rehabilitation. Researchers must focus their efforts on accurately identifying the attributes of individuals following traumatic brain injury which assist in

maximizing adaptation, as well as minimizing the impact on families and significant others. The question should not be "can we afford to provide this rehabilitation" rather it should be "how do we afford the care and make it the best we possibly can".

The questions should be how do we maximize adaptation thereby producing fewer complications, fewer social problems, and more productive citizen. By conducting and utilizing studies of adaptation and studies of the effectiveness of a rehabilitative regime on adaptation, a stronger basis will be available with which to answer these questions, and inevitably, the questions which will surface in the future.

Appendix A

GLASGOW COMA SCALE

Scale	Score
EYE OPENING	
None	1
To Pain	2
To Speech	3
Spontaneous	4
BEST VERBAL RESPONSE	
Mute/Intubated	1
Incomprehensible sounds	2
Inappropriate words	3
Confused conversation	4
Oriented	5
BEST MOTOR RESPONSE	
Flaccid	1
Extensor response	2
Flexor response	3
Semi-purposeful	4
Localizes to pain	5
Obeys commands	6

*The basis of the score is the patient's response to the examiner's specific requests. For each of the three parameters on the scale - eye opening, best verbal response, and best motor response - the patient function is graded and scored. The three parameters are summed for the overall score. The lowest possible score is 3: the highest score is 15.

(Jennett, B. & Teasdale, G. [1974]. Assessment of Coma and impaired consciousness: a practical scale. <u>The Lancet</u>, <u>2</u>, 81-83.)

Appendix B

BRAIN INJURY PROGRAM
*FUNCTIONAL ASSESSMENT WORKSHEET

Scale: 7 Complete Independence (Timely, Safely) 3 Moderate Assist (50-74% of task)
6 Modified Independence (Extra time, device) 2 Maximal Assist (25-49% of task)
5 Supervision (Cueing) 1 Total Assist (less than 25% of task)
*Adapted from Santa Clara Valley Medical Center

Name:______________________________Date of Head Injury:___________Admit Date:___________

Sex:__________Age:__________Length of Coma:_______Discharge Date:________________

SELF CARE ITEMS
1. Feeding
2. Grooming
3. Bathing
4. Dressing Upper Body
5. Dressing Lower Body
6. Toileting
* **7. Swallowing**

SPHINCTER CONTROL
8. Bladder Management
9. Bowel Management

MOBILITY ITEMS
10. Bed, Chair, Wheelchair
11. Toilet
12. Tub or Shower
* **13. Car Transfers**

LOCOMOTION
14. Walking/Wheelchair
15. Stairs
* **16. Community Mobility**

COMMUNICATIONS ITEMS
17. Comprehension
18. Expression
* **19. Reading**
* **20. Writing**
* **21. Speech intelligibility**

PSYCHOSOCIAL ADJUSTMENT ITEMS
22. Social Interaction
* **23. Emotional Status**
* **24. Adjustment to Limitations**
* **25. Employability**

COGNITIVE FUNCTION
26. Problem Solving
27. Memory
* **28. Orientation**
* **29. Attention**
* **30. Safety Judgment**

*Indicates 12 items added to the original 18-item Functional Independence Measure (FIM) to create the Functional Assessment Measure (FAM).

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