NORTHERN ILLINOIS UNIVERSITY

An Investigation of the Role of Physical Therapy in the Treatment of Patients with

Traumatic Brain Injuries

A Thesis Submitted to the

University Honors Program

In Partial Fulfillment of the

Requirements of the Baccalaureate Degree

With University Honors

Department of

Physical Therapy

By

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May 2013

HONORS THESIS ABSTRACT THESIS SUBMISSION FORM

AUTHOR: Kristin Strupp

THESIS TITLE: An Investigation of the Role of Physical Therapy in the Treatment of Patients with Traumatic Brain Injuries

ADVISOR: Becky Wagner

ADVISOR'S DEPT: Health and Human Sciences

DISCIPLINE: Physical Therapy

YEAR: senior

PAGE LENGTH: 30

BIBLIOGRAPHY: yes

ILLUSTRATED: yes

PUBLISHED (YES OR NO): no

LIST PUBLICATION: n/a

COPIES AVAILABLE (HARD COPY, MICROFILM, DISKETTE): hard copy

ABSTRACT (100 – 200 WORDS):

Physical therapy as a form of treatment for individuals with traumatic brain injuries is a complex area in which continued research is necessary. The purpose of this investigation is to research various types of diagnostic tools and interventions that can be utilized during the physical therapy process at each stage of the injury. Furthermore, this investigation proposes a possible treatment plan for an individual with a traumatic brain injury. Several scholarly articles were used to conduct this work. This investigation may be used as a tool for students and professionals to better understand how physical therapy can be successful for the recovery of individuals with traumatic brain injuries.

University Honors Program

Capstone Approval Page

Capstone Title (print or type):

An Investigation of the Role of Physical Therapy in the Treatment of Patients

with Traumatic Brain Injuries

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Date of Approval (print or type):

12-6-12

An Investigation of the Role of Physical Therapy in the Treatment of Patients with Traumatic

Brain Injuries

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December 6, 2012

Traumatic brain injuries (TBI) are a significant public health condition that may affect physical, cognitive, and psychosocial functioning for a lifetime.¹ According to the Centers for Disease Control and Prevention, TBIs play a role in 30.5% of all injury-related deaths in the United States and accumulated \$76.5 billion in medical costs in 2010. There are approximately 5.3 million Americans living with a disability as a result of a TBI.² One person dies and another becomes disabled as a result of TBI every 5 minutes in the United States.³ The fact that personal identity is often defined by an individual's ability to accomplish and participate in the world¹ highlights the need for professionals in the health care field to address this prevalent condition. Emerging treatment methods, such as physical therapy, are providing a promising outlook on this major public health concern.

Before investigating the treatment methods, it is important to understand the classifications and different types of TBIs. First, TBIs can be classified as open or closed injuries. Open injuries occur when an object penetrates the skull and either fractures or displaces it. With this type of injury, there is a greater risk for infection and damage tends to be focused on the path of the penetrating object.¹ The second classification of TBIs, a closed injury, occurs when an impact to the head causes the brain to move within the skull, resulting in brain damage without fracturing the skull.²

Closed TBIs can be broken down into several subtypes. The first, a concussion, is the most common and involves a momentary loss of consciousness and reflexes.¹⁻² Symptoms fall into four categories: thinking and remembering, such as difficulty concentrating; physical, such as dizziness; emotional and mood, such as irritability; and sleep related, such as difficulty falling asleep.² Most individuals recover from a concussion quickly and fully. However, for some symptoms may persist for several months.² Concussions are considered mild TBI because loss of consciousness lasts for less than 15 minutes if at all.⁴

The second subtype of a closed TBI is a contusion. A contusion occurs when the impact causes bruising and hemorrhaging of small blood vessels on the surface of the brain. A coup lesion is a contusion on the same side of the brain as the impact. A contrecoup lesion occurs on the opposite side of the impact, as a result of the brain's rebounding movement. The prognosis and extent of the injury greatly depend on the amount of force that impacted the head.¹ An additional subtype of closed head TBI is vascular hemorrhage with hematoma formation.

An epidural hematoma forms between the dura mater and skull and typically develops after a blow to the side of the head or from motor vehicle accidents. This type of hematoma requires surgery to cease blood from continuing to leak from the ruptured vessel and prevent further deterioration of the individual's condition.¹ On the contrary, a subdural hematoma forms between the dura and arachnoid and is often seen in older adults who have fallen. Unlike in epidural hematomas, blood leaks from the ruptured vessel slowly. Surgery may be necessary depending on the size of the clot.¹ These types of TBI may be moderate if loss of consciousness lasts from 15 minutes to a few hours or severe if loss of consciousness lasts for more than 6 hours.⁴

Locked-in-syndrome (LIS) is another subtype of closed head TBI.¹ TBI is the second leading cause of LIS following stroke.⁵ It is a rare neurological disorder in which the individual develops complete paralysis of all voluntary muscles except those involved in eye movement but maintains consciousness and cognitive functioning.¹ Most often the preservation of vertical eye movements and the ability to blink is the individual's only way to communicate.⁵ In a survey of individuals diagnosed with LIS, all belonging to the Association of Locked-in Syndrome of France, a majority of the individuals who had visual deficits had LIS originated by TBI.⁵ All of the surveyed individuals reported being sensitive to touch to any part of their bodies.⁵ This poses a challenge for the rehabilitation process. Unfortunately, LIS is often misdiagnosed as akinetic mutism or the vegetative state; according to the previously mentioned survey, the average elapsed time from onset until accurate diagnosis was 78.76 days and in most of these cases a family member was the first person to recognize that the individual could still communicate.⁵ Delayed diagnosis and lack of recent information and data on LIS contribute to its poor prognosis.⁵

Acquired brain injuries may also develop following closed head TBIs. Specific causes may include electrical shock, cerebrovascular accident, and airway obstruction. Acquired brain injuries affect cells throughout the brain and may impair memory, reasoning, cognition, and speech-language communication.¹

The treatment methods used for an individual with TBI heavily depend on which problem areas are present. One common problem area is decreased level of consciousness. An individual with TBI may progress through several stages of consciousness that may include stupor, delirium, and clouding of consciousness. The progression includes the return of orientation and memory; however, the length of each stage is highly variable and may cease at any time.³

Individuals with TBIs may also exhibit sensory deficits, such as the inability to smell or visual and perceptual difficulties.¹ These visual and perceptual deficits may make it difficult for the individual to judge distances of sounds and cause overly slow and cautious gait.³ Some individuals may experience behavioral deficits such as irritability, aggression, and low frustration tolerance.¹ These characteristics may challenge the health care professional to adapt his or her treatment methods.

Communication deficits are also a common problem area. In some cases, motor deficits, such as abnormal tone or posturing, inhibit the patient's ability to communicate. The techniques used by physical therapists to address these motor deficits may promote the initiation of physical or verbal responses of the patients.¹ Each of these aforementioned problem areas may indirectly

make it more difficult for the patients to reach their greatest potential and for the rehabilitation professionals to treat them.

Other problem areas have a more direct effect on the course and outcome of the rehabilitation process. For instance, cognitive deficits, which may include memory loss, poor organizational and reasoning skills, an inability to control emotions, and an impaired ability to learn new skills, may be particularly challenging.¹ The ability to learn new skill is vital for any individual receiving rehabilitative services.

Motor abnormalities are also a significant problem area that must be considered during the rehabilitation process. For instance, a patient may have decerebrate or decorticate rigidity

(Fig. 1), which are abnormal postures often exhibited following brain stem injuries. Abnormal postures such as these create a challenge for both the patient and practitioners by making voluntary active movement difficult or impossible.¹ Other common motor deficits include monoplegia, hemiplegia, abnormal reflexes, and muscle flaccidity or spasticity.³ Lastly, traumatic events that cause TBI often

Figure 1- Types of Rigidity¹



A. Decerebrate rigidity is characterized by hips that are adducted and internally rotated, extended knees, plantar-flexed ankles, and supmated feet. The upper extremities are extended at the shoulders and internally rotated, extended at the elbows, pronated at the forearms, and flexed at the wrists and fingers



B. Decorticate rigidity is characterized by adducted and internally rotated shoulders, flexed elbows and wrists, pronated forearms, and extension of the lower limb;

cause other associated problems such as fractures, lacerations, and spinal cord injuries which provide a challenge for the patient and rehabilitation professional.¹

Numerous treatment methods have been utilized to address these problem areas in each type of TBI. Current medical treatment plans for patients with TBI typically consist of specialized prehospital care, intensive clinical care, and long-term rehabilitation.⁶ More specifically, these types of plans initially focus on managing respiratory dysfunction, monitoring

cardiovascular function, treating raised intracranial pressure (ICP), surgical intervention if necessary, and general medical care.³ Several types of pharmacological interventions have been used during these early stages and later on in the recovery process as well. For instance, drugs such as mannitol, glucocorticoids, and barbiturates have been used to decrease ICP. Other drugs, like baclofen, are used to treat increased muscle tone; however, this drug often causes lethargy, confusion, and a reduced attention span.³ In some cases, antidepressants may be used during later stages to treat aggressive behaviors.³ Long-term rehabilitation continues to challenge the brain, which contributes to improved motor control and overall recovery.³

The aforementioned challenge occurs because participating in activities changes the





brain structure and organization.³ Physical therapy is a common participatory, rehabilitative service. The expected outcomes of therapy are to increase the patient's independence and his or her ability to perform activities of daily living. Ideally, physical therapists are able to prevent impairments, functional limitations, and/or disabilities by identifying the disablement risk factors that

provides services to a patient, they use the following patient management steps: examination, evaluation, diagnosis, prognosis, intervention, and outcomes assessment as illustrated by Figure $2.^{1}$

Regardless of the type of injury or condition, it is important to begin treatment by examining the patient in order to determine his or her current state, which will serve as a reference to judge the patient's improvements throughout the entire treatment process.³ The initial examination may be difficult due to the close associate of cognitive, behavioral, and

physical functioning following the traumatic injury; these areas will become more independent as the patient progresses through the stage of recovery.³ Following the examination is the evaluation, which is a process by which the physical therapist makes a clinical judgment based on an assessment.⁷ The evaluation takes testing, motivation, and psychosocial factors into consideration.³ Table 1- Glasgow Coma Scale.¹

The Glasgow Coma Scale (GCS), shown by Table 1, is one cognitive evaluation method used for TBI patients to assess the arousal level and function of their cerebral cortex. The scores range from 3-15. A score of 13 or higher on the GCS indicates the patient has sustained a mild TBI.¹ Patients with a score of 9-12 have moderate TBI, and scores of 8 or below indicate the patient has sustained a severe brain injury and is in a coma.¹ Survival rates for patients assessed at a 3 or 4 are low.¹ For those who score moderate to severe TBI, cognitive impairment is the main contributor to disability.³

Score Spontaneous 4 To speech 3

To pain	2
No response	1
Motor Response	Score
Obeys verbal command	6
Localized	5
Withdraws to pain	4
Decorticate posturing	3
Decerebrate posturing	2
No response	1
Verbalbresponse	Score
Oriented	5
Conversation confused	4
Use of inappropriate words	3
Incomprehensible sounds	2
No response	1

The Rancho Los Amigos Scale (Table 2) is another evaluation tool used to explain

	2- Ranchos Los Amigos Scale
I	No response to visual, verbal. tactile, auditory, noxious stimuli
1	Generalized response
111	Localized response
IV	Confused-agilated
٧	Confused-inappropriate
VI	Confused-appropriate
VII	Automatic-inappropriate
VIII	Purposeful and appropriate
IX	Purposeful and appropriate (standby assistance on request)
x	Purposeful and appropriate (modified independent)
From o	cn.aacnioumals.org 2007

behavioral, cognitive and emotional changes that occur during healing. It is unique because it is based on the patient's response to external information and doesn't require his or her cooperation.⁴ The scale ranges from levels 1-10. Patients in level 1are unresponsive to voices, sounds, light or touch. On the other hand, those in level 10 are able to function independently and perform multiple tasks at a time, but they may become irritable and require periodic breaks.⁴ Although this is scale is considered an effective way to determine patients' cognitive abilities, some may fit the description for more than one level at any given time and plateau at any stage.¹

The JFK Coma Recovery Scale is a tool that may be used to measure hearing, vision, movement, communication, and arousal to determine the patient's long-term prognosis .⁴ It consists of six subscales, each ordered in a hierarchical manner.⁸ The lowest item on each hierarchy represents reflexive activity, and the highest represents cognitively-mediated behaviors.⁸ The JFK Coma Recovery Scale was developed to be useful during Rancho Levels I-IV and has been used extensively in both clinical and research settings.⁸ It has been found that the JFK Coma Recovery Scale accurately predicts an individual's Disability Rating Scale score outcome at one year.⁸ This is significant because a study by Giacino and Croll in 1991 found that the Disability Rating Scale score has a predictive relationship with the anticipated recovery time of specific neurological signs and functional outcomes.⁸

Motor functioning is also a significant area that must be examined and evaluated for TBI patients. The physical therapist must determine if the patient is capable of performing voluntary, isolated activity of a specific muscle or if the patient can only perform movements that are involuntarily linked together.⁷ According to the Bobath concept, the ability to selectively limit and combine movements into the desired function in various environmental conditions is necessary to achieve efficient motor functioning.⁹ This ability will allow the individual to develop effective movement patterns, such was walking, reaching, and postural transitions.⁹ Several tools have been developed to assess motor disabilities such as loss of mobility in bed, loss of household and community ambulation, and loss of activities of daily living in patients with TBI.³ For instance, the Barthel Index is a simple tool that asks whether a patient can perform functional skills such as grooming, feeding, and dressing in a reasonable amount of

time. Likewise, the Functional Independence Measure and Functional Assessment Measure are often used in combination to evaluate an individual's independence.³

When examining the patient's motor functioning, it is also important to address his or her impairment level, which includes flexibility, muscle strength, reaction time, sensation, vestibular function, and tone.³ When evaluating flexibility, both tone and tissue factors should be identified and active and passive motion should be compared. This is important because increased muscle tone is often the limiting factor for adequate flexibility. Certain muscles may not have enough strength to overcome the increased tone, which limits the patient's range of motion. Tools such as tape measures, inclinometers, goniometers, photographs, motion analysis systems, or electronic devices may be used when evaluating flexibility.³

Addressing muscle strength is particularly important because strengthening programs improve the functional abilities of patients with neurological injuries.³ In patients with TBI, motor unit atrophy is often found as well as alterations in their properties due to reduced activity.³ Strength can also be examined functionally by having the patient complete activities such as lifting his or her arm overhead or standing up from a sitting position. In some cases, individual muscle testing may need to be done, using methods such as manual muscle testing or force transducers.³ Reaction time, often measured by EMG, is also an important factor of an individual's impairment level. It examines the time it takes to respond to a stimulus.³

Sensory impairments may affect primary or cortical sensations. Proprioception, considered a primary sense, is important because it includes the ability to distinguish motion and motion direction at each joint.³ Likewise, the primary sense of vision is a critical part of motor function because it helps control anticipatory movements. For instance, vision, in combination with adequate reaction time, may help a patient make appropriate changes before walking onto a different surface. Vision can be assessed using methods such as tracking and observing pupil constriction and dilation.³

The vestibular system is essential for proper motor functioning because it monitors position of the head in space and distinguishes when the body is moving opposed to the visual surroundings.³ Dizziness, inadequate eye/head coordination, and postural and balance complications are often associated with vestibular impairments.³ For instance, balance complications often occur because information from head movements is not correctly translated to cue postural responses¹, which will likely impair the individual's ability to walk and maintain posture under certain conditions. These impairments may be assessed by observing head movement in lying, sitting, and standing positions or by noting dizziness with body, head, or eye motions.³ These symptoms would clearly effect a patient's motor functioning.

The last main impairment to be considered is tone. Increased tone in patients with TBI often appears as a response of the central nervous system to compensate for loss. The therapist

must identify several factors including whether increased or decreased muscle tension is present at rest, and if it is increased, whether it is occurring at the muscle or neurological level.³ Muscle level involvement is common among inviduals with TBI.³ Electromyography is often a useful diagnostic tool when determining the type of tone that is present.³ This

irade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the ROI:1 when the affected part(s) is moved in flexion or extension
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
2	Nore marked increase in muscle tone through most of the ROM, but affected part(s) easily moved
3	Considerable increase in muscle tone, passive movement difficult
4	Affected part(s) rigid in flexion or extension

Table 3

determination will assist the therapist in choosing the appropriate intervention techniques. Spasticity is a velocity-dependent increase in tonic stretch reflexes accompanied by the inability to rapidly turn off muscles, changes in muscle fiber properties, lack of force production, and changes in response to stretch.³ The Modified Ashworth scale (Table 3) is an effective tool when examining muscle tone.³

Following the examination and evaluation, the physical therapist will use the gathered information regarding the patient's impairment level and functional limitations to determine his or her diagnosis. The physical therapist will then establish the patient's prognosis and plan of care.¹ This includes determining optimal short and long-term goals, the amount of time needed to reach these goals, the types and timing of interventions to be used, and anticipated discharge plans.¹ Appendix A proposes a possible plan of care for an individual who sustained a severe frontal lobe TBI. Establishing goals is a way to increase the patient's motivation. Some patients may set goals for themselves that seem unrealistic. However, these goals should not be dismissed because as the patients progress through rehabilitation, they will likely adjust the goals to be more appropriate. Sometimes, time outside of therapy may be needed to foster this readjustment.³ Completion of these steps of the patient management process will segue into the next step: intervention.

The intervention allows the physical therapist to interact with the patient and administer therapeutic techniques intended to produce positive changes in his or her condition consistent with the diagnosis and prognosis.¹ Table 4 lists the procedural interventions in the preferred order of use. It is important to remember that these interventions must be adapted to each patient and rehabilitation setting. The therapist will also assess the patient's condition throughout the rehabilitation process for new clinical findings or lack of progress.¹ The most frequent disabilities following TBI are the loss of mobility and comprehension.³ These areas should be addressed at all stages of intervention.

Procedural Intervention	Description
Therapeutic exercise	Activities to improve physical function and health status; performed actively, passively, or against resistance
Functional training in self-care and home management	Activities to improve function in activities of daily living and independence in home environment
Functional training in work, community, and leisure integration or reintegration	Activities to integrate or return the patient/client to work
Manual therapy techniques	Skilled hand techniques on soft tissues and joints
Prescription, application, and as appropriate, fabrication of devices and equipment	Selection (or fabrication), fit, and training in the use of devices and equipment to improve function
Airwary clearance techniques	Activities to improve airway protection, ventilation, and respiration
Integumentary repair and protective techniques	Activities to improve wound healing and scar management
Electrotherapeutic modalities	Use of electricity to decrease pain, swelling, and unwanted muscular activity; maintain strength; and improve functional training and wound healing
Physical agents and mechanical modalities	Use of thermal, acoustic, or radiant energy and mechanical equipment to decrease pain and swelling and improve skin condition and joint movement

Table 4- Procedural Interventions Used in Physical Therapy.⁷

At the acute stage, the goals of intervention are to increase the patient's level of arousal, prevent secondary impairments, improve functioning, and educate the patient and family about the injury.¹ A physical therapist can contribute to increasing the patient's awareness by referring to subjects that the patient is familiar with during treatment sessions even if he or she is verbally or physically unresponsive. Communicating with the patient and his or her family about treatment will help build rapport and education about what to expect. Although reviews of its effectiveness are still being conducted, auditory, olfactory, tactile, kinesthetic, and oral sensory stimulation may be another way to increase the patient's arousal.¹ The Rappaport Coma/Near-Coma Scale may be used to assess the patient's responses to auditory, visual, olfactory, tactile, and painful stimuli.¹ It also takes the individual's attempts at vocalizations, ability to respond to

a threat, and ability to follow a one-step command into consideration.¹ This assessment method is used upon admission and is repeated regularly to document progress.¹

Patient positioning is also an important part of early intervention. For instance, the supine position allows both nursing and self-care tasks to take place. However, the supine position also allows the greatest impact of the tonic labyrinthine reflex (Figure 3) and dominance of extensor tone to be seen. It is more ideal to position the patient on his or her side or semiprone with upper extremities slightly abducted and externally rotated; this will decrease the effect of

the tonic labyrinthine reflex and inhibit abnormal muscle tone that may quickly develop.¹ The sitting position is particularly important as well because it can increase the patient's arousal and challenge his or her posture.¹ The goal of sitting is to have the patient achieve a neutral pelvic position while keeping their head and trunk



From www.usdb.org

upright.¹ The therapist may have to transfer the patient from the supine position to sitting if they are not able to do so without assistance.¹ Sample treatment methods and exercises for the acute stage of intervention for a patient with severe TBI can be found in Appendix B. The acute intervention stage typically lasts for a short period of time; patients are then discharged to either an inpatient rehabilitation facility or home, where they typically attend outpatient rehabilitation.

Decreased range of motion, increased muscle tone, and abnormal posturing continue to be areas of concern in inpatient rehabilitation settings.¹ Appropriate positioning, typically sidelying and prone, are still considered the most desirable positions. However, as the patient progresses, he or she may become acclimated to sitting in an upright position. This stimulates endurance and bronchial hygiene. A tilt-in-space wheelchair, which allows the patient to recline while keeping the hips, knees, and ankles at 90-degrees, may be necessary for patients who do not have head and trunk control, such as those in levels 2 and 3of the Rancho Los Amigos Scale.¹ During these stages, the individual will begin responding to auditory and painful stimuli.¹

Once patients with fair head and trunk control are able to tolerate the sitting position, which should occur during level 4 of the Rancho Los Amigos Scale, the physical therapist should assist the patient in being able to independently operate the wheelchair.¹ When doing this, it is important for the therapist to be aware of ICP cautions. For instance, cervical flexion, percussion and vibration techniques, and coughing may increase ICP.¹ Head and trunk control may be facilitated by performing therapeutic techniques with the patient in the prone or prove over a wedge position because these require the patient to use his or her cervical extensors against gravity and inhibit the supine tonic labyrinthine reflex.¹ Utilizing range-of-motion exercises during the early stages of rehabilitation will inhibit the development of abnormal tone or contractures. The therapist should choose efficient exercises that stretch multiple muscles at a time and utilize functional positions or developmental postures instead of static stretching whenever possible when working with patients with TBI.¹ It is likely that the therapist will have to utilize methods to inhibit abnormal muscle tone, such as prolonged stretching, weight bearing, and tendon pressure, to be able to attempt functional activities with the patient and promote motor relearning.

Repetition of well-learned or automatic activities like washing the face or brushing the teeth often facilitate motor learning more than newly learned activities do.¹ This can be seen in individuals in level 5 of the Rancho Los Amigos Scale. Although the individual may be able to perform the activity, he or she may not be oriented and may demonstrate inappropriate use of objects without guidance.¹ Having the patient stand while completing these activities is an alternative way to promote weight bearing and sensory input. As individuals progress to level 6

of the Rancho Los Amigos Scale, their orientation will improve and they should be able to complete familiar tasks with only moderate guidance.¹ As an individual's independence increases, he or she will progress through the stages of the Ranchos Los Amigos Scale. By the final stage, level 8, the individual should be consistently oriented and able to complete familiar activities for one hour in distracting environments.¹ Sample therapeutic techniques and exercise for the inpatient rehabilitation intervention setting for a patient with severe TBI can be found in Appendix C. Eventually, the patients should be able to progress to stepping and gait training activities¹ that would be emphasized in their outpatient rehabilitation as well.

Outpatient physical therapy is often the last rehabilitation setting for patients with TBI. As previously mentioned, strength training programs are a fundamental component of improving a patient's functional abilities³, and thus, they are an area often focused on during outpatient rehabilitation. It is critical to use resistance at various speeds in order to challenge the rate at which motor units fire and improve strength. Functional activities, such as sitting and standing, can also be useful in improving strength.³ Studies suggest that several repetitions of task-specific activities are necessary to promote neuroplastic change.¹⁰ In fact, without high numbers of repetitions, functional improvements may be limited.¹⁰ Setting specific treatment goals for each treatment session encourages a much higher number of repetitions to be completed.¹⁰ Various models of therapy should be considered in order to maximize the amount of practice the patients get such as group therapy, circuit training, or alterations in daily therapy schedules.¹⁰ However, the therapist must take very weak muscles into consideration when treating patients as well. These muscles may become fatigued and will not respond to treatment as rapidly. In cases such as this, it may be useful to decrease the resistance or number of repetitions to make the process more efficient.³

Decreased flexibility can occur rapidly in patients with TBI due to increased muscle tone and lack of activity. Two factors must be considered when treating a patient for decreased flexibility: the soft tissue around the affected joint must be allow the joint surfaces to glide, roll, and spin; and joint's muscles must be the appropriate length to allow motion. Any imbalances within the joint can lead to improper posture and body mechanics, as well as many other musculoskeletal problems.⁷ This problem can be treated with joint mobilization, stretching, dynamic splinting, serial casting, and electrical stimulation.³ Electrical stimulation is also an effective modality when treating upper-extremity losses in patients with TBI. Some patients can learn to relax and release their grip in response to continuous low-level stimulation.³

Similarly, electrical stimulation may be used for the improvement of tone. For instance, it may be used to activate specific muscles in a specific order to assist a patient with gait training or ankle strategy retraining.³ Gait improving interventions are often utilized on patients with TBI who display hypertonia in their lower limbs. Typically, the gait of patients with TBI can be characterized by a slower walking pace and shorter steps. In some cases, the patient may also display longer stance and double support phases, lower cadence, and wider step width.¹¹ Plantar flexor and hip flexor strength must be increased adequately enough be able to push-off and swing the more affected limb forward in a coordinated manner in order to increase the walking speed of patients with TBI.¹¹ Breaking gait training down into subtasks may be helpful for the patient. For instance, the therapist and patient may focus first on stepping from the fully extended position to the initial contract position by practicing thigh flexion at various speeds.³ Gait training can also be addressed using whole-task practice. However, this poses safety concerns because a patient who cannot walk may fall when asked to do so. The use of devices, such as parallel bars or soft mats may decrease this risk.³ Often, the limb that is less affected also displays gait deviations because compensatory walking strategies.¹¹ Correcting the deviations of

the more affected limb will likely reduce the need for these compensatory actions, hopefully restoring a normal gait pattern in the patient.

Reaction time may be addressed during outpatient rehabilitation by having the patient stand on a foam pad during weight shifting to a visual stimulus.³ Reaction time is an important contributor to maintaining balance as previously mentioned. The vestibular system may also

Figure 4- Canalith Repositioning Maneuver



Step	Description
1	Position patient in the long sitting position.
2	Rotate the patient's head 45 degrees toward the right.
3	Lower the patient into the supine position with the neck extended 20 degrees over the edge of the table.
4	Rotate the head 90 degrees, ending in 45 degrees of neck rotation toward the uninvolved side.
5	Roll the patient onto the uninvolved side while maintaining the head-on-trunk position and sit up.

problems of the vestibular system, the therapist may need to provide specific sensory information to enhance input from normally functioning systems. Many patients with TBI experience benign positional vertigo, which requires canalith repositioning maneuvers to be corrected, as shown by Figure 4. These maneuvers reposition the otoliths within the ear, which respond to head movement and can detect acceleration and tilt.³ Patients with

contribute to balance. To address sensory

From www.apta.org

a TBI involving the occipital lobe often display visual impairments that can be corrected with oculomotor exercises.³ Sample therapeutic exercises and techniques for the outpatient rehabilitation setting for a patient with severe TBI can be found in Appendix D.

It is evident that in all intervention settings- acute, inpatient, and outpatient- there are several variances in treatment approaches and methods. However, some generalizations about these therapeutic interventions can be made. Teaching functional skills is critical for all levels of patients with TBI.³ Typically, lower-level-functioning patients with TBI require a significant

amount of hands-on assistance from the therapist while focusing on motor improvement. Treatment for these patients should emphasize strength, flexibility, timing, and sequencing of movements. Assistive devices such as braces and neck supports are often used in place of missing functional components, such as strength and stability.³ These types of devices may assist the individual in maintaining a specific posture needed to complete activities; for instance, upright sitting is the ideal position for activities of daily living.¹ Stabilizing the trunk may contribute to improving the individual's ability to maintain the head in midline.¹ Breaking activities down into subtasks may be an effective method for patients who cannot manage multiple tasks at one time. More complex activities like line dancing, karate, or handball, may be used to facilitate balance, sequencing, and speed of movement progress in higher-level patients.³ For all patients with TBI, repetition of functional activities and practice in various environments are critical to learning new skills, treatment goals should be incorporated into movements. The therapist should encourage the patient's independence in problem solving and when performing activities by choosing activities that the individual finds most enjoyable but still focus on the deficits being targeted.³

Many of the treatment and handling approaches to neurological physical therapy interventions used today stem from approaches that were developed by physical therapists beginning in the 1940s.⁷ Although the efficacy of these approaches is still being researched, some of their methods continue to be used today. The first is the proprioceptive neuromuscular facilitation, which emphasizes the fact that most activities require the use of several muscles in combination. For example, even when an individual selectively moves a single joint, the body automatically balances unwanted forces at other joints.⁹ Specific movement patterns are significant during the retraining process of this approach. This approach also found that providing proprioceptive stimuli at specific locations and times enhanced motor performance.⁷ The next approach, founded by Margaret Rood, also emphasized the importance of sensory stimuli, particularly in arousing, calming, and modulating motor responses. The autonomic nervous system was also considered a contributing factor to the patient's motor control. A skeletal function sequence was also developed by this approach, which consists of four basic stages: mobility, stability, controlled mobility, and skill.⁷ Current approaches emphasize active involvement by the patient as opposed to passive handling because they focus on the principles of motor learning and skill achievement. According to these approaches, the physical therapist is responsible for establishing an appropriate environment and use of feedback in order to encourage learning. It is suggested that the interaction of the patient, the task, and the environment in which the task takes place leads to movement.⁷

The final stage of the patient management process is the outcomes assessment. During this stage, the physical therapist must determine the impact the completed interventions have had on the patient's functional status and quality of life.¹ This assessment may be completed during a reexamination, which will determine if goals and outcomes are being achieved and if modifications to the plan of care are needed.⁷ This determination should take the following factors into consideration: pathology, impairments or disabilities, prevention, health and wellness, societal resources, and patient satisfaction.¹ Upon achievement of the treatment goals and outcomes, the therapist can discharge the patient and services will terminate.⁷

Physical therapists continue to adapt their treatment approaches and interventions for each unique case of patients with TBI. It is evident that many of the impairments that occur as a result of TBI are similar to impairments associated with other medical conditions, such as stroke. This is an important factor when investigating effective forms of physical therapy. Physical therapists diligently work with other members of the rehabilitation team to improve the quality of life and increase the independence of patients with TBI.¹ Advances in medical technology and method are leading to a good prognosis for these patients. For instance, 97 percent of the 1.57 million Americans who sustained a TBI in 2003 survived.¹⁰ It is clear that physical therapy can be an effective treatment method for individuals with TBI when used appropriately. However, continued research in this area of study is needed to further understand the complexity of TBI and continue to develop improved treatment methods.

Appendix A: Plan of Care

Dear Doctor,

The patient, James Jones, was seen today for an initial evaluation with the following results:

Description: This patient is a 23-year-old white male post severe TBI to the frontal lobe.

Diagnosis: Status post severe frontal lobe TBI

History: The patient is a 23-year-old white male involved in a motor vehicle accident on 10/18/12. The patient sustained severed TBI to the frontal lobe. The patient was unconscious for approximately 7 hours. The patient was transported to the emergency department by ambulance. He was in the intensive care unit from 10/18/12-10/21/12. He is medically stable and has been treating with an occupational therapist. The patient has limited ambulation of the lower limbs, communication skills, and trunk stability. He was referred to physical therapy.

Past Medical History: Unremarkable.

Medications: Norco and Amoxicillin

Subjective: The patient appears to be in a moderate level of pain. He rates it at a 6/10. His main concern is regaining full use of his lower limbs.

Objective:

Range of Motion: Bilateral hip flexion is 100 degrees. Bilateral knee flexion is 115 degrees. Bilateral upper extremities are within normal limits.

Strength: Bilateral lower extremities are grossly 4/5 with one repetition. The right upper extremity is 5/5. The left upper extremity is 3/5.

Balance: The patient performed moderately when standing with eyes opened and closed with the assistance of a walker.

Gait: The patient ambulates slowly with short steps and requires the assistance of a walker.

Assessment: Examination indicates deficits in strength and ambulation. Skilled physical therapy will be beneficial for the patient's functioning and quality of life.

Treatment Plan: The patient will be seen daily while in the hospital and inpatient rehabilitation. Upon discharge from inpatient rehabilitation, the patient will be seen 3 times per week for 6 weeks in outpatient therapy. The patient will be reexamined at that point to determine the need for further treatment. Interventions will include therapeutic exercise, gait training, and functional mobility training.

Short term goals to be achieved in 4 weeks:

- The patient is to complete 2x10 side lying abductions with proper form to demonstrate increased strength for gait stability.
- 2. The patient is to be able to stand for 1 minute unassisted to demonstrate improved balance for increased safety in home.
- The patient will ambulate 1000 feet with a cane in a 6-minute walk test to demonstrate the ability to cross the street in his community..
- The patient will increase bilateral passive range of motion hip and knee flexion by 15 degrees for leg clearance during the swing phase of gait.

Long term goals to be achieved in 8 weeks:

- 1. The patient will ambulate 1500 feet in a 6-minute walk test with no assistance.
- The patient will navigate independently over and around objects safely without loss of balance.
- 3. The patient will demonstrate normal range-of-motion of all affected joints.

The above treatment plan and goals have been discussed in detail with the patient and his mother. The prognosis is good. They are in agreement.

Appendix B: Acute Intervention

The following therapeutic exercises and techniques may be used at the acute intervention stage

for the patient outlined in Appendix A.

Positioning:

Figure 4: Side-Lying Position



In the proper side-lying position, one end of the footboard is beneath the mattress (A), the extended arm is supported by a rolled pillow (B), and the arm is well-supported in the corrected position.¹

Figure 5: Prone Positioning



Prone positioning can be achieved in patients even with severe contractures with the use of different supports.¹ Figure 6: Rolling Supine to Right side Lying



Sitting:

Figure 7: Supine-to-Sit Transfer



The supine to sit transfer is performed by having the therapist's arm around the patient's flexed knee and the other arm beneath the patient's neck (A), then the patient's legs are brought over the side of the bed (B), the trunk is lifted vertically (C), and the head and trunk are supported while preventing the knees from sliding forward (D).¹ Physical Therapy for patients with TBI 24

A therapist can assist a patient from rolling from supine to the right side by first kneeling just left of the patient's left lower extremity and grabbing the patient's dorsal foot with the right hand and the posterior tibia with the left (A). Next, the therapist shifts her weight forward as the patient assists in rolling to the right side (B). To return to supine, the therapist places her right hand on the patient's posterior knee and her left hand on the plantar surface of the foot as the patient assists (C). Lastly, the patient completes the transition as the therapist shifts her weight onto her back leg (D).¹





Various sitting activities are effective in increasing posture and trunk strength, such as rotating the trunk forward with the arm supported sideways (A) or rotating the trunk back with the contralateral arm abducted (B).¹

Appendix C: Inpatient Rehabilitation

The following therapeutic exercises and techniques may be used during inpatient rehabilitation

for the patient outlined in Appendix A.

Functional Activities:

Figure 9: Ambulation Assistance



Assistive devices, such as a walker, may be used to improve the patient's functional abilities, such as ambulation.⁷ Figure 10: Functional Activities



Mimicking daily activities with functional activities, such as descending a step, help improve motor functioning.⁷



Figure 11: Assisting Ambulation

The therapist lifts the patient's upper trunk up and back using an axillary grip (A). The therapist helps initiate movement from the aptient's legs in right step/sance by using her left hand. The patient must be taught how to shift weight over both legs without excessive leaning (B). Forward and backward weight shifting are repeated in the right and left step/stance positions (C). The therapist supports the patient's upper trunk using an axillary grip of the right hand while her left hand is on the posterolateral side of the left rib cage (D). The patient must keep her upper trunk extended while shifting her trunk and hips forward \in . The therapist must time corrections and assistance in sync with the patient's movements (F).¹

Balance:

Figure 12: Balance Activity



Balance boards are a simple, effective way to improve balance.⁷

Appendix D: Outpatient Rehabilitation

The following therapeutic exercises and techniques may be used during outpatient therapy for the patient outlined in Appendix A.

Flexibility/ range-of-motion:

Figure 13: Myofascial Release



Myofascial release techniques are an effective and gentle way to manually stretch soft tissue. Example A, demonstrates this technique performed on the posterior of the thigh and, B, the temporomandibular joint region.⁷

Figure 14: Range-of-Motion Activities



Range-of-motion exercises are used to maintain or improve joint motion. A rod can be used in simple active assistive exercises for the shoulder, as in A. Pendulum exercises are a method of active free exercises.⁷

Reaction Time:

Figure 15: Reaction Time Activity



Having the patient stand on foam blocks will help improve speed of motion and reaction time, which is an important contributor to balance.³

Strength:

Figure 16: Mechanical Resistance Methods



Various methods are effective in using mechanical resistance during exercise, such as free weights, A, and elastic tubing, B. Both are inexpensive and readily available.⁷

Figure 17: Strength Exercise



Therapists may assist patients complete activities such as this to improve strength and balance.⁷

Gait: Figure 18: Facilitating and Assisting with Swing Phase of Gait



The process begins with the therapist facing the patient. The therapist initiates the swing phase of gate through manual contacts and by assisting at the ischial tuberosity, while using the other hand to facilitate trunk extension (A). The therapist then assists the patient's right lower extremity through midswing (B). Next, the therapist makes contact with the posterior pelvis to facilitate weight transfer onto the right lower extremity (C). The therapist may make manual contact with the posterior thigh to assist swing phase initiation (D). The patient progresses through midwing (E). Lastly, the therapist makes manual contact with the posterior thigh to promote weight transfer onto the right lower extremity (F).¹

References

- Martin S, Kessler M. Neurologic Interventions for Physical Therapy. 2nd ed. St. Louis, MI: Saunders Elsevier; 2007.
- Traumatic Brain Injury. Centers for Disease Control and Prevention Website. http://www.cdc.gov/TraumaticBrainInjury/. Published 2011. Accessed October 1, 2012.

Umphred D. Neurological Rehabilitation.4th ed. St. Louis, MI: Mosby Inc; 2001.

Understanding Brain Injury [DVD]. Atlanta, Ga: Shepherd Center, KPKinteractive; 2012.

- Leon-Carrion J, Van Eeckhout P, Dominguez-Morales M, Perez-Santamaria F. The locked-in syndrome: a syndrome looking for therapy. *Brain Injury*.2002;16: (7): 571-582
- Xiong Y, Mahmood A, Chopp M. Emerging treatments for traumatic brain injury. *PubMed*. 2010; 14: 67-84.
- Pagliarulo MA. Introduction to Physical Therapy. 3rd ed. St. Louis, MI: Mosby Elsevier; 2007.
- Kalmar K, Giacino J. The JFK coma recovery scale-revised. *Neuropsychological Rehabilitation*. 2005; 15: (3/4): 454-460
- Graham JV, Eustace C, Brock K, Swain E, Irwin-Carruthers, S. The bobath concept in contemporary clinical practice. *Top Stroke Rehab.* 2009; 16 (1): 57-68
- Kimberley TJ, Samargia S, Moore L, Shakya J, Lang C. Comparison of amounts and types of practice during rehabilitation for traumatic brain injury and stroke. *Journal of Rehabilitation Researach & Development*. 2010; 47: (9): 851-862

Chow JW, Yablon SA, Horn TS, Stokic DS. Temporospatial characteristics of gait in patients with lower limb muscle hypertonia after traumatic brain injury. *Brain Injury*. 2010; 24: (13/14): 1575-1584