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Functional Mobility Training after a Severe Traumatic Brain Injury Suffered in a Motor Vehicle Crash: A Case Report

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Abstract

Background & Purpose: Recovery after severe traumatic brain injury (TBI) often involves prolonged immobility, resulting in decreased balance, strength, and endurance, and increasing the risk of secondary complications such as wounds, contractures, and respiratory illnesses. The purpose of this case report is to describe the acute rehabilitation course of a patient with a severe TBI and emphasize the role of physical therapy in preparing the patient for the next level of care. **Case Description:** 31-year-old male found unresponsive after a rollover motor vehicle crash, which resulted in a severe traumatic brain injury, a subdural hematoma, and several orthopedic injuries to the spine and mandibular condyle. He had a prolonged hospitalization complicated by ventilator-associated pneumonia, respiratory failure, tracheobronchitis, dysautonomia, and hyponatremia. Physical therapy interventions during the acute hospitalization included positioning, bed mobility, range of motion, transfers, balance, and gait training. **Outcomes:** The patient was treated daily for 30 days during his acute hospital stay with an AM-PAC Inpatient Basic Mobility Short Form (“6-clicks”) score improvement from 6 to 9. Alternative measures include the GOSE, ACIF and AlphaFIM. **Discussion:** Physical therapists play an integral role in the acute recovery of severe TBIs to improve functional mobility and prevent secondary complications associated with prolonged immobility. This case demonstrates the importance of early mobilization despite having a poor prognosis for independent mobility and in the presence of impaired consciousness.

Introduction

Traumatic brain injury (TBI) is defined as a disruption in the normal function of the brain that is caused by a bump, blow, or jolt to the head.[34] The public health burden of traumatic brain injuries is substantial. 153 people in the U.S. die each day from injuries that include TBI, costing an estimated $76.5 billion each year.[28] In 2013, these injuries caused 2.5 million ED visits and 282,000 hospitalizations.[28]

The severity of traumatic brain injury is classified according to criteria developed by Teasdale and Jennet, who defined the Glasgow Coma Scale (GCS) in 1974 based on patients' motor responses, verbal responses, and eye opening. The Glasgow Coma scale allows classification of traumatic brain injury as mild, moderate, or severe and is used as soon as possible after the injury, and at variable times thereafter. Scores 3-8 are classified as severe TBI, 9-12 as moderate TBI, and 13-15 as mild TBI.[29] Severe TBI requires aggressive management and often results in cognitive and physical manifestations that lead to long-term disability. It is estimated that 5 million people in the United States suffer from long-term disability after TBI.[12] Severe injury causes not only permanent neurological deficits (20% of adults) but it has been shown that 20%–40% of patients end up dying as a result of brain injury or secondary complications.[24] Other studies report mortality rates as high as 76% to 89%.[27] The two most powerful predictors of negative outcome are GCS score of ≤5 and absent pupillary reactions, both of which are present in this case report.[27]

Traumatic brain injuries result in a multitude of clinical manifestations due to both neural damage and other concurrent injuries such as orthopedic fractures, integumentary wounds, and/or vascular damage, in addition to secondary conditions that develop post-injury. Clinicians should anticipate deficits in arousal, attention, cognition, cardiorespiratory function and endurance, joint integrity, motor function, and functional mobility.[22]

Physical therapy is an accepted and common aspect of recovery after TBI given the prolonged bed rest and deep sedation often involved. In the acute impatient phase of care, the aim is to improve motor and functional recovery while preventing or treating secondary complications by encouraging movement and upright posture. Sequelae such as neuromuscular weakness, reduced aerobic capacity, and persistent participation restrictions often follow a stay in the ICU.[23]

In this case report, early functional mobility training was initiated based on well-documented evidence to support its effectiveness in improving patient outcomes. Physical therapy in the ICU appears to improve quality of life, physical function, peripheral and respiratory muscle strength, increasing ventilator-free days, and decreasing hospital and ICU stay.[16] According to the Evidence-Based Review of Acquired Brain Injury project, there is Level 2 evidence to support that early rehabilitation is associated with better outcomes such as shorter comas and lengths of stay, higher cognitive levels at discharge, better FIM scores, and a greater likelihood of discharge to home.[31] Interventions are aimed at minimizing joint stiffness, muscle shortening, and sensory deprivation, facilitating balance, and enhancing quality of movement.[33] Hellweg et al. determined that functional training directly results in improved sit to stand transfers, upper extremity use, and gait.[11] Animal models demonstrate that early training (freedom to move) and an enriched environment (the presence of others) improves functional recovery. Motor skills training may enhance adaptive neural plasticity or similar reorganizational processes that may contribute to restoration of function.[20] After brain injury, the sensorimotor experiences of the individual shape this neural remodeling, suggesting that physiotherapeutic interventions target the neuroplastic potential of the human brain.[21]

In the acute hospitalization, early transitioning from supine to sitting is encouraged, resulting in improvements in functional residual capacity and more uniform ventilation and perfusion. In addition, gravity aids in mobilization of secretions within the lungs.[8] Facilitating positional changes by standing brain injured patients who were vegetative or minimally conscious showed significant improvement in arousal and/or awareness. Positional changes have also been shown to prevent hypovolemia, alter resting muscle length, load vertebrae, redistribute skin pressure, benefit the respiratory system, reduce osteoporosis, improve circulation, and aid renal function.[3]

Despite an impaired level of consciousness, initiation of physical therapy as soon as medically appropriate may lead to improved outcomes. Edlow et al. found that MRI and EEG can detect covert consciousness and cortical responses in patients who lack behavioral evidence of consciousness, providing evidence that patients may recover consciousness before behavioral indications are present. Lack of a reliable clinical tool to detect consciousness delays and limits access to rehabilitative care.[7] In this case, early initiation of physical therapy despite impaired consciousness was important to maximize the patients' rehabilitation potential.

Widespread use of outcome measures such as the AM-PAC "6-clicks" makes it an easy-to-use and readily available tool for clinicians to monitor patients' functional status. It relies on the reliable measurement and determination of the level of assistance required to complete a mobility task, a skill all physical therapists and nursing staff are trained to do. Furthermore, as it indicates in the name, the "6-clicks" only requires 6 clicks to complete so is an efficient tool to document patient performance.

The purpose of this case report is to describe the acute rehabilitation course of a patient with a severe TBI and emphasize the role of physical therapy interventions, particularly functional mobility training, in preparing the patient for the next level of care and in preventing secondary complications associated with immobility.

Case Description

This patient case was selected due to the unique challenges of patients suffering from a sequela of complications associated with severe traumatic brain injuries, including impairments of consciousness, and the absence of similar cases reported in the literature. In addition, the cultural situation described here reveals social conflicts to consider when managing a patient care plan.

History

The patient was a 31-year-old Hispanic male who was found unresponsive inside his vehicle after a rollover motor vehicle crash. He presented to a Level I trauma center intubated and sedated with a large degloving scalp laceration, hypotension, and acute respiratory failure. CT scan revealed a subdural hematoma along the falx cerebri, dislocation of the left mandibular condyle, complete atelectasis of the right upper lobe of the right lung, fracture of left C6 facet and lamina, compression fractures at T7 and T9-T11, fracture of spinous process at T8, and transverse process fractures of L2 and L3. MRI revealed diffuse axonal injury bilaterally along the corpus callosum. The patient demonstrated anisocoria with fixed and dilated right pupil. He was found to have a blood-alcohol level of 0.174 and was in hemorrhagic shock due to bleeding of the scalp laceration.

Initial medical management ensured stabilization of all vital functions. His mandibular condyle injury was treated with ORIF and all other orthopedic injuries were managed non-operatively. The patient regained consciousness 10 days post-injury, but continued to have impaired consciousness. His Glasgow Coma Scale score was 3 at initial presentation, indicating severe TBI.

Past medical and surgical history were unknown and no family history was available at initial evaluation. Later, as family members were contacted, it was determined that the patient was independent with mobility and self-care prior to the accident. He was employed as a construction worker, however, the details of his job were not known. Family indicated that the patient was a healthy, adult male with no significant health history and occasional consumption of alcohol and use of tobacco. It was later discovered that the patient lived alone in a two-story home owned by his employer. The home has four steps to enter, and the patient has his own living space on the first floor with a full bathroom and bedroom on the ground level.

The patient was Spanish-speaking and from Mexico, where his family resides. His family was required to speak to the Mexico consulate to obtain visitor visas, but the patient's sister was denied that visa. He was not a U.S. Citizen and therefore did not qualify for Medicaid, resulting in denial of coverage for inpatient rehab outside of the admitting hospital. Family members completed an emergency Medicaid application and applied for the Carle Financial Assistance Program. It was made clear to family members that the patient would likely require 24-hour care upon discharge and that the

family will need to provide that. The family was prepared to move the patient back to Mexico, where the patient has more family support.

Examination

The initial evaluation was conducted as a co-treatment with Occupational Therapy on hospital day 18. It is unknown why there was a delay in ordering physical therapy. Orthopedic physicians ordered that spinal precautions be followed, along with wearing hard cervical collar at all times and TLSO brace when out of bed**.** The patient was on Optiflow to his tracheostomy and his PEG tube feedings were paused and disconnected. A Spanish interpreter was used during every therapy session.

The patient aroused to voice and repeated touch, but did not keep eyes open for more than a few seconds and did not follow commands or visually track therapist. The patient moves all four extremities to pain, and makes non-purposeful movements of all extremities throughout session. His communication was impaired by language and cognition; therefore, orientation was not assessed. The patient's arousal state was most consistent with Ranchos Los Amigos Level II.

Table 1. Medication list for the patient at Initial Evaluation.

Medication	Purpose
0.9% NaCl infusion IV	Treat Hyponatremia
Acetaminophen 500mg oral	Pain relief
Amantadine 150mg	Treat disorder of consciousness
Ampicillin-sulbactam 3g IV	Treat bacterial infection
Bisacodyl (Dulcolax) suppository 10mg	Treat constipation
Famotidine (Pepcid) 20mg IV Push	Stress ulcer protocol, GERD
FentaNYL PCA 50mc/mL IV	Pain relief
Heparin 5,000 units	Prevention of DVT/PE
levETIRAcetam (Keppra) 1,000mg.	Prevention of seizure
levofloxacin (Levaquin) 500mg.	Treat bacterial infection
Modafinil (Provigil) 50 mg.	Improve wakefulness
Propanolol 10mg	Treat hypertension

The therapist was unable to assess AROM or MMT, but PROM of all extremities was within functional limits. Minimal spasticity was noted in left hip flexors. Manual muscle testing (MMT) was attempted, however, the patient was not able to follow directions. Based on his spontaneous movement of all extremities, he was assumed to have >3/5 MMT grossly. Blood pressure, heart rate, and oxygen saturation were within normal limits at rest, however, the patient became hypertensive and tachycardic with mobility. Integumentary screening revealed a large scalp laceration and mild edema of bilateral upper extremities.

The patient completed a log roll to the right and left with total/dependent assistance of two persons. He then performed a supine to sit transfer with total/dependent assist of two persons. He sat on the edge of bed with feet supported with varying levels of assistance from total to moderate. The patient's arousal did not improve with upright positioning. He became tachycardic and hypertensive after sitting for 5 minutes. He was found to have delayed postural adjustments, impaired lumbar extension and trunk elevation, impaired protective responses, impaired midline awareness, and posterior trunk lean. Additional mobility tasks were not tested due to safety concerns.

Evaluation

Upon completion of the initial evaluation, the therapist concluded that the patient demonstrated deficits in range of motion, bed mobility, transfers, balance, and gait. The patient was limited by muscular weakness, fatigue, pain, impaired motor recruitment, incoordination, and impaired consciousness. He was also limited by a TLSO brace, a Miami J collar, and a tracheostomy tube. Impairments found included aerobic capacity/endurance; arousal, attention, and cognition; balance;

gait, locomotion; initiating and executing movement; muscle performance; orthopedic/trauma restrictions; pain; postural orientation; weakness. Movement faults contributed to decreased independence with mobility, inability to tolerate continuous activity, instability in sitting, impaired safety awareness, inefficient task performance, need for fall prevention, need for education to promote further gains, maintain status and prevent decline, and need for family training to promote further gains. It was determined that the patient was appropriate for physical therapy interventions to improve the noted impairments and independence with functional mobility tasks.

The diagnosis assigned to this patient was described as ICD-10-CM code S06.2X6: “Diffuse traumatic brain injury with loss of consciousness greater than 24 hours without return to pre-existing conscious level with patient surviving.” (Guide)

Early signs and symptoms are not clearly predictive of patient outcomes, making prognosis difficult to predict.[9] Anticipated impairment recovery was determined to be “fair,” indicating 30-75% recovery of all impairments. Functional recovery was determined to be “fair,” meaning the patient will likely recover to Independent to Minimal assistance required at home. It is not likely this patient will achieve functional independence. Long-term limitations are expected, likely requiring 24-hour care for the near future. This prognosis was determined based on clinical judgement given the information acquired in the evaluation.

Plan of Care

The treatment plan consisted of functional training, gait training, monitored mobility, positioning, and therapeutic exercise with physical therapy treatment sessions occurring daily. The discharge recommendation at the time of initial evaluation was Inpatient rehabilitation. The PT determined the supervision needs of the patient were significant such that the patient may not be alone.

Family was not present for the initial evaluation and due to the patient’s impaired consciousness, patient goals were unable to be obtained. The therapist determined appropriate goals based on clinical judgement.

Table 2. Short-term and Long-term goals.

Short term goals: to be achieved in 2 weeks.	
Log rolling	min verbal cues, flat bed, mod A.
Supine->Sit	min verbal cues, flat bed, mod A.
Sit to Stand	min verbal cues, from bed, FWW, Max A.
Bed to chair	min verbal cues, stand and step with FWW, Max A.
Maximize level of arousal, optimize positioning, medical management	
Long term goals:	
Transfer skills	Minimal assistance
Mobility skills	household & community ambulation: Minimal assistance
Assistive device	walker

Interventions

Therapy interventions followed a neurostimulation schedule such that the patient received therapy at 8:00am every morning, and other types of stimulation at two-hour intervals only during the daytime hours. The aim was to gradually activate the reticular activating system in the brainstem and re-introduce sensory stimulation including light, sound, and movement. Evidence supports periods of sedation interruption, with the goal of a daily episode of awakening followed by exercise or mobilization.[23]

Arousal was assessed at each treatment session and cognitive functions were trained by teaching the patient to perceive verbal information from the therapist and concentrate attention to the movement being performed. The therapist gave clear, simple, single-step instructions and allowed for

cognitive processing delay, working towards a consistent response such as facial expression, change in muscle tone, or visual tracking.

It was vital to make thorough observations of the patient during each session. Due to the patient's impaired ability to express pain, facial expressions and vital signs were monitored during treatment as possible indications of pain. Skin checks were completed by nursing staff daily in addition to observations completed by the physical therapist during mobility tasks as hidden aspects of the body were revealed. Observation of posture was an additional responsibility of the therapist, as an indication of pain, autonomic function, or neurological syndromes. Abnormal extension posturing was noted, with a resulting diagnosis of paroxysmal sympathetic hyperactivity, also named sympathetic storming, which researchers find and incidence of 8% to 33% in TBI Patients.[22] Other symptoms noted included episodes of tachycardia, hypertension, diaphoresis, and dystonia, all of which are consistent with sympathetic hyperactivity.[10]

Continuous monitoring of the patients' response to activity was vital to make accurate assessments and alter the plan of care appropriately. A patient's functional capacity may fluctuate on the basis of a myriad of influences on physiologic homeostasis, such as adjustment of ventilator support, medications, or other activities that have been performed that day. Therefore, the physical therapist must be vigilant to the indicators of the patient's responses to an activity.[23]

Weeks 1-3:

The first few weeks of physical therapy treatment sessions focused on prevention of orthopedic and integumentary complications. Treatment consisted of positioning with pillows, wedges, and other devices to offload bony prominences including calcaneus, greater trochanter, ischial tuberosity, sacrum, occiput, and olecranon, along with turning every 2 hours. The patient was making non-purposeful movements of all extremities and as a result was intermittently placed in mitts for his hands due to risk of pulling lines. Passive range of motion was performed in an effort to allow spontaneous and free motor activity to ankle, knee, hip, shoulder, elbow, and wrist. Resting night splints and PRAFO boots were used to prevent plantarflexion contractures. A specialty "low air loss" mattress was used to decrease the risk of pressure sores.

The second major intervention included positional changes to improve tolerance to upright sitting. Bed mobility and supine to sit transfers, along with sitting balance were emphasized. Therapists used bed sheets along with low friction sliding aids such as MaxiSlide to complete transfers. Verbal and tactile cues were employed to educate the patient on proper logroll technique. The supine to sit transfer was performed with Total/dependent assistance during the first three weeks.

The patient's tolerance to sitting at the edge of the bed was monitored closely with vital signs, non-verbal indicators of pain, and amount of assistance provided. Blood pressure was monitored with an electronic cuff and the patient wore an abdominal binder. He progressed from an initial 5 minutes of sitting tolerance to 15 minutes after three weeks. The level of assistance provided improved from total/dependent assistance to moderate assistance for sitting balance. After the patient demonstrated tolerance to upright sitting with stable vital signs, Nursing staff was advised to put the patient's bed in "chair position" three times/day.

During this initial phase of treatment, the patient remained obtunded and intermittently semicomatose, only arousing to constant, vigorous stimulation.

Week 4:

The next phase of treatment focused on facilitation of standing tolerance and gait. The patient completed sit to stand transfer training with maximal assistance of two persons which improved to moderate assistance of two persons. The therapists provided assistance by blocking the patients' knees and providing a forward weight shift and trunk lift, while giving tactile cues for extension through the thoracic spine. The patient was found to demonstrate impaired weight shifting, impaired force production, impaired control of descent, insufficient active weight bearing in bilateral lower extremities, and shifted center of mass posteriorly resisting correction.

For two days during this week, physical therapy treatment was limited due to the patient's TLSO brace being misplaced during his transfer from the ICU to the Neurology floor. During these two days, the patient was instructed in therapeutic exercise, but was not following commands to complete the exercises so required maximal assistance to complete. Once the TLSO brace was returned to the patient, upright activities were progressed. The patient began to take his first steps during this week. He required maximum assistance of two persons for large weight shifts and forward progression of swing leg. The therapists used their own leg and foot to advance the swing limb forward while also facilitating a weight shift towards the stance limb and blocking the knee of the stance limb. The patient also required tactile cueing at one shoulder to facilitate trunk extension. The patient was able to tolerate 12ft of this gait before he began to fatigue and could no longer hold any of his body weight.

Sitting balance was also progressed with the patient tolerating manual perturbations in all directions requiring minimal assistance to maintain balance. He tolerated 5 minutes of sitting balance with perturbations. The patient did not follow commands to reach for objects so reaching activities were avoided. Static sitting balance improved to requiring minimal assistance intermittently due to the patient's impaired midline awareness. Nursing began to get the patient up to a geri-chair three times each day, using a Hoyer lift due to safety concerns with transfer.

Week 5:

The Patient was determined to have a GCS score of 9 at 8 weeks post-injury. He was alert but quiet and withdrawn with a flat affect. This week he began to direct his gaze towards people making sounds and movements, but did not maintain gaze for more than a few seconds. The speech-language pathologist completed a counting activity when the patient mouthed three numbers across multiple trials. He began to follow simple, one-step commands for mobility. Use of "sit up," "stand," and "walk" were successful.

He completed sit to stand transfers with moderate assistance from two persons. He increased his gait distance to 25ft with maximal assistance of two persons with step-through pattern and no cues or assistance for weight shifts. His gait distance was limited by fatigue. During this week, the patient achieved a gait distance of 45ft, but continued to require maximal assistance of two persons. By the end of this week, he was able to complete the same amount of distance with moderate assistance of two persons.

Week 6:

This was the final week of the patient's acute hospitalization before being discharge to the inpatient rehabilitation unit in the same hospital. He began to track with his eyes on the television and towards faces when commanded to "mirame" ("look at me"). He completed bed mobility and supine to sit transfers with maximal assistance of two persons. He stood with only minimal assistance of two, but required moderate assistance for control of descent during stand to sit transfers. He did not progress gait distance during this week and continued to require a similar amount of assistance as the week prior. He was able to use a front-wheeled walker for ambulation this week and required verbal and tactile cues for device negotiation. The patient demonstrated the ability to initiate stepping without any cues for progression of swing leg this week. The table below shows the patient's progress, requiring less assistance over time.

Table 3. Assistance required for mobility tasks over time.

	Bed mobility	Supine->Sit	Sit->Stand	Gait
Week 1-3	Total	Total	Did not attempt	Did not attempt
Week 4	Total	Total	Max Ax2	12 ft. Max Ax2
Week 5	Total	Max Ax2	Mod Ax2	25 ft. Max Ax2
Week 6	Max Ax2	Max Ax2	Min Ax2	45 ft. Mod Ax2

Outcomes

The Boston University Activity Measure for Post-Acute Care (AM-PAC), also known as "6-clicks," was used as the main outcome measure. This computer-based measurement was scored based on clinicians' responses to six questions asking to rate the amount of "difficulty" and "help from another person" the patient required to complete certain mobility tasks (see **Appendix A**). Answers were selected based on observed patient performance or the clinician's professional judgment of expected patient performance. The mobility tasks include turning over in bed, moving from lying on back to sitting on side of bed, sitting down and standing up from a chair with arms, moving to and from a bed to a chair, walking in hospital room, and climbing 3-4 steps with a railing.[14]

Table 4. AM-PAC definition of mobility descriptors.

"Difficulty" Items	
"Unable"	If the patient is not able to do the activity.
"A lot"	If it is a struggle, requiring great effort and/or time.
"A little"	If the patient can manage to do the activity, but it takes more effort and/or time than you think it should.
"None"	If the patient does not experience any problems.
"Help from another person" Items	
Total	Total/Dependent Assist
A lot	Max/Mod Assist
A little	Min/Contact Guard Assistance/Supervision
None	No human assistance used

The patient initially scored the lowest possible score of 6 at the time of the initial evaluation. At the time of discharge from the hospital, after daily physical therapy for 30 days, the patient improved his score to 9. The patient improved from being "unable" to sit down and stand up from a chair, move from lying on back to sitting on the side of the bed to having "a lot" of difficulty with those tasks. He also improved in the amount of help needed from another person to walk in a hospital room from "total" to "a lot." The MDC_{90} was reported to be 4.02. The MCID is not established.[14] Test-retest reliability and subject-proxy reliability were found to be good to excellent.[1] The items used in the 6-clicks were found to be valid, sensitive, and responsive for assessing patients' activity limitations in acute care settings.[18] In a sample of patients with major neurologic, orthopedic and medical impairments, the AM-PAC demonstrated a high degree of measurement sensitivity.[15] A retrospective review from the Cleveland Clinic provides evidence of the accuracy of the "6-Clicks" scores in predicting discharge destination.[15]

The patient's final score of 9 indicates he has "a lot" of difficulty, or is "unable" to perform the basic mobility tasks without assistance, requiring total or maximal or moderate assistance. The patient improved in the tasks of sit to stand transfer, bed to chair transfer, and walking, scoring an additional point for each for demonstrating "a lot" of difficulty and requiring "a lot" of help. This interpretation agrees with this patient's prognosis. It was anticipated that the patient would require 24-hour care for the rest of his life and would not achieve independence with mobility.

Other outcome measures that could have been used in this case include the Extended Glasgow Outcome Scale (GOSE), the Acute Care Index of Function (ACIF), the AlphaFIM. The advantage of using these alternative outcome measures is they evaluate other aspects of the patients' function aside from only physical mobility functioning. These scales evaluate psychological and social deficits, which account for much of the disability TBI patients suffer from in their daily lives. This allows the clinician to consider the whole person rather than only his or her physical limitations, resulting in a more comprehensive understanding of the patients' functioning and can help clinicians problem solve barriers to progress and possible solutions to improve functioning in daily life.

Discussion

Despite minimal improvements in performance and the continued reliance on assistance for mobility tasks, this patient case does not invalidate the effectiveness of physical therapy interventions. Clinicians must consider the effectiveness of PT intervention in the prevention of secondary complications that could have had life threatening effects. In this case, the prevention of wounds, contractures, and respiratory illnesses with positioning, range of motion, and upright posture, respectively, contributed to shorter length of stay and earlier discharge to acute rehabilitation. In addition, the effects of intervention may not manifest in measureable improvements in mobility, but rather serve as neural priming for the long-term rehabilitation of motor function. Clinician's should guide treatment by the primary goal of neurological rehabilitation, which is to guide neural reorganization in a manner that facilitates recovery of function.

This case report described acute physical therapy interventions in the treatment of an adult with a severe traumatic brain injury. The outcomes fail to demonstrate a significant improvement in functional ability, however, the absence of secondary complications associated with immobility and the progression of mobility with decreasing levels of assist demonstrate the effectiveness of the physical therapy interventions. At hospital discharge, the patient was ready to transition to inpatient rehabilitation, where he would receive more intensive and specific therapy interventions and make significant improvements in functional mobility. This case serves as an addition to the limited research evidence available for physical therapy treatment of severe TBI and reinforces the importance of physical therapy for these patients in the acute care setting.

Despite common and expected use of physical therapy for patients following TBI, there remains only a small amount of evidence to support its effectiveness in improving patient outcomes in this particular population. Studies have demonstrated significantly improved functional mobility outcomes, including reduced length of stay and cost of care in neuro/trauma patients participating in a structured mobility program in the ICU.[8] A 2008 systematic review of physiotherapy after TBI concluded, "Strong evidence exists that intensive task-orientated rehabilitation programs lead to earlier and better functional abilities."[11] However, there continues to be a lack of evidence regarding the effects of impaired levels of consciousness on physical therapy treatment effectiveness. There is a particular lack of information regarding type, intensity, frequency, and duration of treatments. This may be due to the heterogeneity of traumatic brain injuries and associated injuries, ethical implications of using control groups in RCTs, and the interdisciplinary quality of rehabilitation making it difficult to study the impact of physical therapy alone.[4] Researchers do agree that the most effective treatment approach is one which is multidisciplinary and goal-oriented, with early and often involvement of all members of the healthcare team, along with family education and involvement. Further research is needed to demonstrate the effectiveness of specific physical therapy interventions to facilitate motor recovery and ultimately functional recovery in the traumatic brain injury population.

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Appendix A

AM-PAC Inpatient Basic Mobility Short Form

Boston University AM-PAC™
Basic Mobility Inpatient Short Form '6 Clicks'

Please check the box that reflects your (the patient's) best answer to each question.

How much difficulty does the patient currently have…	Unable	A Lot	A Little	None
1. Turning over in bed (including adjusting bedclothes, sheets and blankets)?	☐1	☐2	☐3	☐4
2. Sitting down on and standing up from a chair with arms (e.g., wheelchair, bedside commode, etc.)	☐1	☐2	☐3	☐4
3. Moving from lying on back to sitting on the side of the bed?	☐1	☐2	☐3	☐4

How much help from another person does the patient currently need…	Total	A Lot	A Little	None
4. Moving to and from a bed to a chair (including a wheelchair)?	☐1	☐2	☐3	☐4
5. Need to walk in hospital room?	☐1	☐2	☐3	☐4
6. Climbing 3-5 steps with a railing?	☐1	☐2	☐3	☐4

Raw Score: _____ CMS 0-100% Score: _____

Standardized Score: _____ CMS Modifier: _____

Note: Use the AM-PAC Basic Mobility Inpatient Short Form Conversion Table to convert raw scores.

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Fillable form available online at: https://www.pdffiller.com/jsfiller-desk2/?projectId=155549256&expId=2990&expBranch=1#525019707df741fd8fd52dd40e107110
See also References 14 and 15.