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Acute Physical Therapy Management of Pediatric Patient with Traumatic Brain Injury

Michelle Holt

University of North Dakota

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ACUTE PHYSICAL THERAPY MANAGEMENT OF PEDIATRIC PATIENT WITH TRAUMATIC BRAIN INJURY

by

Michelle Holt
Bachelor of Science in Physical Therapy
University of North Dakota, 2007

A Scholarly Project Submitted to the Graduate Faculty of the Department of Physical Therapy School of Medicine University of North Dakota in partial fulfillment of the requirements for the degree of Doctor of Physical Therapy Grand Forks, North Dakota May, 2009
This Scholarly Project, submitted by Michelle Holt in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Graduate School Advisor)

(Chairperson, Physical Therapy)
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ACKNOWLEDGEMENTS

I would like to thank my family for their continued support throughout my education. I would also like to thank my advisor and group members for their time, effort, and help during the process of writing this case study.
ABSTRACT

**Background and Purpose:** Traumatic brain injury can cause many deficits including decreased balance and coordination. The purpose of this case report is to describe the interventions used and subsequent outcomes for a pediatric patient following traumatic brain injury in the acute care setting. Also, this case report serves to describe the methods and tools used in a hospital that is not equipped with pediatric-specific equipment or utilities.

**Case Description:** This paper describes the four-day inpatient physical therapy management of a six-year-old female who fell from a horse and sustained a left open depressed frontal skull fracture with an underlying subdural hematoma. The patient was referred to physical and occupational therapy with left sided weakness and decreased left lower extremity coordination.

**Intervention:** Treatments utilized for this patient included mobility and standing balance activities tailored for the pediatric patient.

**Outcomes:** Following physical therapy intervention, the patient achieved increased lower extremity strength, coordination, and balance.

**Discussion:** Rationale for treatment was based on both textbooks and current evidence
based research. Treatment techniques were also based on improving the deficits in balance and coordination specific to the patient.

**Key Words:** mobility, static balance, dynamic balance, subdural hematoma, TBI
CHAPTER I
BACKGROUND AND PURPOSE

Traumatic brain injury (TBI) is defined by the National Head Injury Foundation as a traumatic insult to the brain capable of producing physical, intellectual, emotional, social, and vocational changes. There are 430000 TBIs in children ages 0 to 14 each year, 90% of which are seen as emergency room visits. TBI in children is also the cause of 2685 deaths and 37000 hospitalizations each year.¹ There are many different mechanisms of TBI in the pediatric population including motor vehicle accident (MVA), falls, and sports or recreational activities. In preschool-aged children 32% of TBIs are from recreational activities and sports, increasing to 42% in 10 to 14 year olds.

A TBI may be caused by either a closed or an open head injury. A closed head injury is one in which the soft tissue of the brain is forced into contact with the skull with no associated skull fracture or laceration to the brain. An open head injury occurs when the meningeal layers have been breached, leaving the brain exposed. Significant bruising and bleeding within the brain results in a severe brain injury. A contusion (bruise) is the hallmark of a TBI and is usually more severe in persons with skull fractures than those without.²

Another classification system for TBIs is whether or not the injury is focal or diffuse. A focal brain injury is localized to the brain under the site of impact on the skull.³ An example of a focal injury is a severe blow to the head where the brain then makes
contact with the opposite side of the skull. This is called a coup-countercoup injury. The
coup injury to the brain is at the site of impact and the countercoup injury to the brain is
opposite the site of impact where the brain hit the skull. Damage from a focal injury
includes hematoma, edema, contusion, laceration, or any combination. The anterior-
inferior temporal lobes and the prefrontal lobes are the most common sights of focal
injury. Diffuse axonal injury (DIA) is caused by acceleration, deceleration, and rotational
forces. Shearing and retraction of damaged axons are what cause the damage in a DIA.
Structures involved may include cortical white matter, corpus callosum, basal ganglia,
brainstem, and cerebellum.³

If a TBI is caused by a severe blunt trauma, it is possible there is a contusion that
could lead to a subdural hematoma.² A subdural hematoma is, by definition, a swelling
comprising a mass of blood beneath the dura.⁴ Acute subdural hematomas present the
largest challenge, with high rates of death and injury. Subacute and chronic subdural
hematomas have good outcomes in most cases, with symptoms disappearing after the
accumulated blood is drained. The major cause of a subdural hematoma is the tearing of
the bridging veins. This tearing causes an increase in intracranial pressure (ICP) resulting
in the displacement of brain tissue. Other sources of subdural hematoma include torn
cortical veins or venous sinuses and contused tissue.⁵

If the subdural hematoma is acute and rapidly developing, as in the case of the
patient reported in this paper, the expanding clots directly compress the brain. The
bleeding is self-limiting due to the increasing ICP, which compresses the bleeding veins.
In the case of an open head injury, surgery to debride the tissue to prevent infection as
well as clot removal to help reduce the ICP is required. Broad spectrum antibiotics are also administered to decrease the chance of infection.\textsuperscript{5}

It is important to understand the probable physical manifestations of the TBI. Abnormal muscle tone and abnormal posture can follow a TBI. Decorticate rigidity presents with lesions at or above the brainstem. Decorticate rigidity is a state in which the upper extremities are flexed and the lower extremities are extended. Lesions in the brainstem between the vestibular nucleus and superior colliculus cause decerebrate rigidity which is exhibited as upper and lower extremity extension. (Mayer N) It is possible for a patient to have decerebrate positioning on one side and decorticate positioning on the other side. Another possibility is for the patient to alternate between decerebrate and decorticate positioning.\textsuperscript{3}

Both mild and severe TBI have been shown to cause a decrease in balance.\textsuperscript{6,7} Further, severe TBI in children causes a decrease in gait speed as well as an increase in step length variability.\textsuperscript{7} Intervention for these deficits will be necessary with acute implementation of physical and occupational therapy as well as other disciplines including nursing.

Intensity of physical therapy (PT) in an inpatient setting has been preliminarily shown to be directly related to an increase in functional mobility scores in pediatric patients following TBI.\textsuperscript{8} Intensity has been defined as the number of 15 minutes units of Physical Therapy charged. On average pediatric patients with a traumatic brain injury are being charged 3 units per day with therapeutic exercise being the most widely used charge. This study uses the charges from an acute care setting to quantify the amount of time spent with the patient as well as to qualify the kind of therapy received. This attempt
to quantify and qualify physical therapy in an acute care setting has shown that physical therapy administered twice a day (increased intensity) increased the patient’s functional mobility. Future studies are needed with controlled variables of physical therapy service, including intensity to determine what effect that may have on changes in function or outcome.

After leaving the hospital following a TBI, children have a reportedly lower quality of life compared to a control group. However, if the children have average academic performance following TBI, they achieved the same quality of life score as the control group. In this study 23 children with TBI were used. On average, all children were in school four years after their TBI and most could walk independently.9 This paper is relevant to this case in determining the possible outcomes of the patient for the health care professional as well as for the family.

This paper describes the four-day inpatient physical therapy management of a 6-year-old female who fell from a horse and sustained a TBI including a left open depressed frontal skull fracture with underlying subdural hematoma. The purpose of this case report is to describe the interventions used and subsequent outcomes for a pediatric patient following TBI in the acute care setting. Also, this case report serves to describe the methods and tools used in a hospital that is not equipped with pediatric-specific equipment or utilities. The initial prognosis is that the patient would have a full recovery, with the most functional gain achieved while in the acute care hospital, utilizing mobility and standing balance activities. Rationale for treatment was based on current evidence-based research. Treatment techniques were also based on improving the deficits in balance and coordination specific to this particular patient’s recovery.
CHAPTER II

CASE DESCRIPTION

Examination, Evaluation and Diagnosis

The patient was a 6-year-old female who was kicked in the head by a horse and suffered a left open depressed frontal skull fracture with an underlying subdural hematoma and right posterior temporal contusion. Upon admittance to the hospital, the patient showed right upper and lower extremity extensor posturing (decerebrate rigidity). The patient was also assessed at a 6T on the Glasgow Coma Scale (GCS) upon admission with the T indicating that the patient had a tracheostomy tube in place. The GCS defines the level of consciousness with an objective numeric value. A fully alert, normal person would obtain a score of 15. Coma is defined by the GCS as a score of 7 or less and decreases the likelihood of a full and complete recovery. It is important to note that the tracheostomy tube limited the verbal response score significantly, and the patient was not comatose upon arrival. The patient underwent elevation and drainage of the subdural hematoma with primary dural closure. Cultures revealed staphylococcus aureus and enterococcus for which the patient was placed on intravenous antibiotics.

The patient had no previous medical history as reported by the family. The patient lived at home with her parents and two siblings. Family also reported that the patient led a normal, active lifestyle for a 6-year-old. She attended kindergarten and there were no
developmental delays or physical abnormalities reported in the patient’s chart. Also, there were no signs of abuse reported.

Three days after admittance to the hospital a standardized occupational and physical therapy functional status evaluation was performed following orders for physical and occupational therapy evaluation and treatment. The evaluation was performed by both an occupational and physical therapist as a co-evaluation. At the time of evaluation the patient’s activity level was out “of bed ad lib and ambulate.”

The patient was alert and oriented to family. The family and patient reported no prior history of falls. The patient reported a small headache at the IV sight. Observation included the notation of left facial edema. Sensation was found to be grossly intact by assessment with the patient reporting sensation of therapist’s hand directly over skin of both upper and lower extremities bilaterally. The patient was right-hand dominant and upper extremity gross motor coordination appeared within functional limits (WFL) as assessed with dysmetria testing (finger to nose). Gross coordination in the lower extremity was assessed and found to be decreased especially by observation of movement throughout the examination and evaluation. Specifically her gait showed an inability to fully synchronize movement of her legs. Initial range of motion and a strength assessment was then taken; refer to Table 1 for measurements. Range of motion (ROM) was within functional limits in all upper and lower extremity motions on both the left and right side. ROM was assessed in the upper extremity with a quick test. The patient was instructed to put her hand above her shoulder and as if she were scratching her back and then to put her hand in the small of her back and reach as far upwards (toward the head) as possible.
### Table 1. Initial Range of Motion and Strength Assessment

<table>
<thead>
<tr>
<th>Joint</th>
<th>Right ROM</th>
<th>Right Strength</th>
<th>Left ROM</th>
<th>Left Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder</td>
<td>WFL</td>
<td>WFL</td>
<td>WFL</td>
<td>WFL</td>
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<tr>
<td>Elbow</td>
<td>WFL</td>
<td>WFL</td>
<td>WFL</td>
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<tr>
<td>Hand</td>
<td>WFL</td>
<td>WFL</td>
<td>WFL</td>
<td>WFL</td>
</tr>
<tr>
<td>Hip</td>
<td>WFL</td>
<td>WFL</td>
<td>WFL</td>
<td>General weakness</td>
</tr>
<tr>
<td>Knee</td>
<td>WFL</td>
<td>WFL</td>
<td>WFL</td>
<td>General weakness</td>
</tr>
<tr>
<td>Ankle</td>
<td>WFL</td>
<td>WFL</td>
<td>WFL</td>
<td>General weakness</td>
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</table>

Lower extremity ROM was assessed at each individual joint with the therapist assessing quality of movement.

Strength was within functional limits for all upper and lower extremity motions on the right as well as all upper extremity motions on the left. A standardized strength assessment using manual muscle testing is also difficult in the pediatric brain injury population due to the need for the patient to follow specific instructions. Instead, it is important to document the patient’s active movements including the ability to move against gravity and support weight. Observation of the child’s gait and mobility was a key, too, as it showed how well she could move her limbs against gravity. To achieve the most accurate strength level assessment, gross testing to find any major impairments or weaknesses was used. In this case, strength was assessed at WFL if the patient was able to move the muscle group against gravity with ease and hold her extremity in place with resistance. A gross test of strength was used with assessment bilaterally at the wrist, elbow and shoulder. To assess strength in the lower extremity the patient was asked to
dorsiflex and plantarflex the ankle, flex and extend her knee, and flex at the hip in a sitting position. The patient was also asked to stand for assessment of her ability to support her weight. Lower extremity hip, knee, and ankle strength appeared to have general weakness on the left side. Lower extremity strength was tested bilaterally with gross strength assessed at the ankle, knee, and hip. The patient was able to bridge with clearance and also bridge with lateral movement. Bridging is the ability to raise the buttocks off of the bed while the patient lies on the back. The legs are bent and the bottoms of the feet in contact with the bed. This is important to note for ability to perform transfers.

The child exhibited fair sitting static balance, fair minus sitting dynamic balance, fair standing static balance, and fair minus standing dynamic balance. Good balance is described as having no deficits (need for assistive device or loss of balance.) Fair balance is described as having balance deficits that include the need for minimal assistance or possible assistive device and do not include a loss of balance. Poor balance would be described as needing full assistance or that the patient demonstrates a loss of balance.

<table>
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<tr>
<th>Table 2. Current Activities of Daily Living Status</th>
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<td>Bed Mobility</td>
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<td>MIA-MOA</td>
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</table>

Bed mobility required minimum to moderate assistance. Sit-to-stand activity required minimum assistance of one. Transfer from the bed to a chair also required minimum assistance of one. Functional ambulation of 25 ft was achieved with handheld assist for balance. The patient was assessed to have a moderate fall risk based on the assessment of
decreased balance. Activity tolerance was fair overall with slight trouble with left lower extremity coordination with gait.

The physical therapy diagnosis for this patient is 5C: Impaired Motor Function and Sensory Integrity Associated with Nonprogressive Disorders of the Central Nervous System--Congenital Origin or Acquired in Infancy or Childhood. Physical therapy was administered as therapeutic exercise, gait training, and therapeutic activities.

Prognosis and Plan of Care

Occupational therapy was delivered for activities of daily living (ADL) training and therapeutic activities. The occupational and physical therapists saw the patient twice a day for respective therapies. The patient’s goals were to return home, attend school, and ride horse. Occupational therapy goals to be achieved by discharge included independence with lower extremity dressing as well as stand by assistance with toilet transfers. Physical therapy goals to be achieved by discharge included independence with bed mobility, standby assistance with transfers and ambulation, and contact guard assistance with ascending and descending stairs to. Focus of interventions for this patient was to increase lower extremity coordination, increase balance, and increase left lower extremity strength in order to achieve patient and therapist goals. The patient was given a good prognosis from physical and occupational therapy, and it was expected that the patient would be discharged to home with the family at the cessation of the hospital stay.
CHAPTER III
INTERVENTION

The patient was seen for 15-to 30-minute sessions two times per day. Treatment was able to be performed on 3 out of the 4 days. The first day included the initial evaluation in the morning and subsequent therapies in the afternoon. In the afternoon a therapy ball was brought to the patient’s room to assist in therapy. Gait was further assessed by ambulation in the hallway with handheld assist for 50 ft. Balance was addressed with sitting and rolling the therapy ball from the patient to a therapist 5 ft away and by stopping the ball with her hands when rolled back to the patient. The patient did well with sitting exercises with no loss of balance. At the same distance this process was repeated in standing. Assist was given when loss of balance occurred. The same exercise was then repeated with kicking instead of catching the ball at the same distance. Assist was given when loss of balance occurred. In both standing exercises the patient had recurrent loss of balance, requiring assistance from therapists.

On the second day patient was unable to attend PT or OT as she was required to undergo a procedure. On the third day the patient was seen twice a day for mobility and standing balance activities. The patient ambulated 400 ft with handheld assist. Single-leg stance balance was achieved for 8 to -10 seconds on the right leg and 9 to -12 seconds on the left leg in the morning treatment session. Toe walking was demonstrated by the patient with no difficulty. The patient was also able to kick a moving ball with either both
lower extremities individually, but prefers to kick the ball with her dominant right leg. The patient experienced one episode of balance loss with kicking. Assistance of one was required for dynamic standing balance activities including walking and kicking the moving ball. A small decrease in coordination was observed on the patient’s left side when compared with the right side. Strength now appeared to be equal bilaterally in the upper and lower extremities.

On the fourth day the patient had no complaints of pain. The patient was able to crawl in and out of bed without assistance. Balance activities were performed in the hallway with handheld assist in a “Simon Says” fashion including: walking on toes forward and backward, walking on heels, marching, and wide-stance gait forward and backward. The game was played by the physical therapist saying, “Simon says, walk on your toes” with the physical therapist demonstrating and the patient following behind. There was one physical therapist, one student physical therapist, and one occupational therapist there. The patient ambulated up and down an incline with a handrail. Standby assistance was also available at this time but the patient performed the activity with no need for support. Dynamic standing balance was assessed by kicking the therapy ball with standby assistance as needed. Lower extremity strength was grossly within functional limits on both the right and left side. Improvement was noted with the gait patterns mentioned above.

The parents of the patient reported that the patient was to leave the hospital on the morning following the fourth day of physical and occupational therapy; therefore the patient was discharged from inpatient physical and occupational therapy. Recommendations were made to follow up with outpatient physical therapy to assist in
recovery of normal gait patterns as well as coordination. The parents were encouraged to continue with single leg stance balance and dynamic standing balance exercises after leaving the hospital.
CHAPTER IV
OUTCOMES

Compared to initial evaluation, the patient made much improvement while in the hospital. Balance improved a great deal with ratings improving from fair to fair minus to good to good minus upon discharge from the hospital. ROM continued to be WFL while strength increased in the left lower extremity. The patient also showed intact cognition. Upon follow up examination by a medical doctor 15 days post injury, the patient was found to have strength of 5/5 throughout.

<table>
<thead>
<tr>
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<th>Right ROM</th>
<th>Right Strength</th>
<th>Left ROM</th>
<th>Left Strength</th>
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</thead>
<tbody>
<tr>
<td>Shoulder</td>
<td>WFL</td>
<td>WFL, 5/5</td>
<td>WFL</td>
<td>WFL, 5/5</td>
</tr>
<tr>
<td>Elbow</td>
<td>WFL</td>
<td>WFL, 5/5</td>
<td>WFL</td>
<td>WFL, 5/5</td>
</tr>
<tr>
<td>Hand</td>
<td>WFL</td>
<td>WFL, 5/5</td>
<td>WFL</td>
<td>WFL, 5/5</td>
</tr>
<tr>
<td>Hip</td>
<td>WFL</td>
<td>WFL, 5/5</td>
<td>WFL</td>
<td>WFL, 5/5</td>
</tr>
<tr>
<td>Knee</td>
<td>WFL</td>
<td>WFL, 5/5</td>
<td>WFL</td>
<td>WFL, 5/5</td>
</tr>
<tr>
<td>Ankle</td>
<td>WFL</td>
<td>WFL, 5/5</td>
<td>WFL</td>
<td>WFL, 5/5</td>
</tr>
</tbody>
</table>

The patient was also found to have intact sensation and clear speech. Per the physician note, gait was not tested by the physician but that according to an (-unknown-) outside source the patient’s gait was normal. It was noted that the family did not pursue physical
or occupational therapy following the hospital stay but did continue to follow up with a medical doctor.
CHAPTER V
DISCUSSION

The purpose of this article was to describe the interventions used and subsequent outcomes for a pediatric patient following TBI in the acute care setting, specifically in a hospital that does not have a pediatric wing/floor and is not generally equipped for pediatric patients. The patient had a tremendous improvement from initial admittance to the hospital ER to discharge. It is likely that age and physical and occupational therapy played a large role in the recovery process as well as prompt medical attention after the accident.

At present, there is no standardized physical therapy recommendation for patients with a TBI. The physical therapy the patient received in the acute care setting was based in principles used for adults with a TBI with adaptations to make the activities more child friendly. Due to lack of pediatric specific equipment for physical therapy sessions, we used a lot of game based therapy and exercises. Betker et al have shown that game-based exercises result in increases in attention volume and attention span in adults with TBI or spinal cord injury. Games were used in this patient’s treatment to prevent boredom and increase the desire to participate. Balance and motor skills were practiced and assessed with games of “Simon Says” and follow the leader with the goal of getting to the nursery to look at the babies and then a continuation of the game back to her room. A large therapy ball was used with scenarios such as playing kickball or catch, which are
common to children of the kindergarten age level. A foam wedge was also used with a handrail to practice walking up and down an incline.

Consistent with past research, the main deficits seen in this patient following TBI were a decrease in balance and gait.6,7 These deficits were treated by both physical therapists and occupational therapists. Dumas et al8 indicated that, following TBI, the intensity of PT is directly related to an increase in functional mobility in pediatric patients. Had the patient been charged per unit for PT services, she would have been charged 3 to 4 units of PT per day which is similar to that in the article. Emerson15 states that mortality in children with a TBI has improved with more aggressive management of the injury. In the chart that Bailes et al16 used as a guideline for PT and OT services in a pediatric medical setting, the pediatric patient would be under the intensive category receiving physical and or occupational therapy sessions 3 to 11 times per week. The articles suggest that the increase in functional mobility of the patient is at least in part due to the intensity of physical therapy she received while in the acute care setting.

Recent research has reflected the possible decrease in the quality of life and deficits in balance and gait for the specific pediatric population following TBI.6,7,9 Rehabilitation often utilizes many different techniques and treatments making it hard to differentiate between the individual treatments or the whole delivery system.18 Future research is needed to find out what specific activities are most helpful for children recovering from a TBI in the acute care setting to eliminate these deficits and increase the quality of life. Specifically, a comparative study utilizing specific balance, gait training, and strength exercises is needed to discover the most effective approach for the pediatric TBI acute care population.
Reflective Practice

The history portion of the examination and evaluation was very complete. As the PT, I was able to see both the physician and social work history in the patient’s chart before the initial patient visit. Additional questions were then asked to determine the patient’s lifestyle and activity level as well as living environment including home layout (number of floors, steps, etc).

I would change the examination and evaluation for future patients in the following ways: addition of a standardized pediatric balance assessment, addition of a functional assessment, addition of formal sensory testing, and addition of formal manual muscle testing. These changes would be made in order to better quantify the patient’s status upon examination and evaluation as well as discharge. Although there was an obvious increase in balance, strength, and mobility there was no way to quantify the changes in a standardized way. All of these components were addressed in the examination and evaluation in a gross manner. The decision for this was based on limitations in therapists’ time and patient’s endurance and attention level as she was assessed. These tests, however, could have been addressed at time of interventions as well.

Interventions were often made into games to increase compliance for the patient. Care had to be taken due to the decreased attention span of the patient to keep her interested in the interventions. Overall, I would have changed little in the plan of care of this patient.
REFERENCES


