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Assessment of Severity Measures used to Predict Prognostic Outcomes in Children with TBI: A Case Report

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Abstract

Background: Traumatic brain injury (TBI) is the number one cause of death and disabilities in the pediatric population. Various injury severity measures are used for patients with TBIs in order to predict expected outcomes. The purpose of this case report is to assess the stark differences in progression and functional outcomes of two children with TBIs who presented similarly at baseline using various severity measures. **Case Descriptions:** Both patients were admitted into inpatient rehabilitation on the same day and presented similarly at baseline: with Functional Independence Measure for Children (WeeFIM) scores of 19 and 18 for Patients A and B, respectively. Yet, they progressed differently during their time in rehab. Patient A was a 53-month-old female who suffered from a left-sided subdural hematoma with blown pupil on her left side and a right-sided skull fracture as a result of a non-accidental trauma. Patient B was a 45-month- old female who had a right-sided subdural hematoma, multifactorial intracranial hemorrhage, pneumocephalus with multiple skull fractures and facial fractures, small left pneumothorax, and a transverse process fracture of the second lumbar vertebrae as a result of a motor vehicle accident. **Outcome Measure:** The raw WeeFIM scores were used to calculate each patient's WeeFIM developmental functional quotient (DFQ). At discharge, the WeeFIM DFQ score for Patient A was 71.87% but only 18.81% for Patient B. The severity measures outlined in this case report include the time from injury to admission into inpatient rehabilitation (TTA), the Glasgow Coma Scale (GCS), duration of post traumatic amnesia (PTA), total duration of impaired consciousness (TFC+PTA), and the time to follow command (TFC). **Discussion:** This case report highlights that the severity measures that were available for each patient would have helped create more accurate predictions for each patient's functional outcomes than simply the WeeFIM score. These predictions are useful when creating treatment plans and educating families on expected outcomes.

Key Terms: Pediatrics, Traumatic brain injury, WeeFIM, Severity measures, Rehabilitation, Physical Therapy

Background and Purpose

Traumatic brain injury (TBI) is the leading cause of death and disability in the pediatric population.[1] There are numerous physical, cognitive, and behavioral consequences following a TBI that affect children for their lifetime.[2] According to the U.S. Centers for Disease Prevention and Control, an estimated 475,000 children between the ages of 0 and 14 sustain a TBI annually.[1] Additionally, the annual death rate resulting from TBIs in children under 4 years of age is 5 per 100,000.[1] Injuries in children 4 years of age and younger are commonly the result of falls, abuse, and motor vehicle accidents.[1]

Formulating an accurate outcome prediction early in the treatment plan is essential for pediatric patients following a TBI for several reasons. The predictions are used by inpatient rehabilitation therapists to determine various aspects of patient care including treatment progressions, discharge recommendations, insurance authorizations, and continued therapy needs.[3] Various injury severity measures have been used to predict functional outcomes of children with TBI who require inpatient rehabilitation. Severity measures such as the time from injury to admission into inpatient rehabilitation (TTA), the Glasgow Coma Scale (GCS), duration of post traumatic amnesia (PTA), total duration of impaired consciousness (TFC+PTA), and the time to follow command (TFC) have been used as predictors of functional outcomes in this population. The Functional Independence Measure for Children (WeeFIM) is a measure of disability and assesses the progress of children throughout inpatient rehabilitation and documents functional independence outcomes at discharge.[4,5] The WeeFIM is designed to be used across all disciplines of the healthcare team, including nursing, physical therapy, occupational therapy, and speech therapy.[5] Though the instrument is designed to be used by all clinicians regardless of discipline, some clinicians prefer to separate the categories. Therefore, the nursing staff addressed bowel and bladder management, physical therapists evaluated transfers, occupational therapists addressed self-care and social cognition items, and speech pathologists assessed the communication items.[5] The purpose of this case report is to assess the stark difference in progression and functional outcomes of two children with TBIs who presented similarly at baseline using various severity measures.

Patient Histories

Patient A:

Patient A was a 53-month-old African American female with no previous medical history. She was admitted to the hospital at the end of July 2019 following a fall in the bathroom resulting in a left-sided subdural hematoma with blown pupil on her left side and a right-sided skull fracture. Due to the trauma, she exhibited tetraparesis and dysphasia. Her Glasgow Coma Scale was a 7 upon arrival at the hospital. On the day of admittance to the hospital, she underwent a left-sided decompressive hemicraniectomy to relieve the intracranial pressure. Imaging reports revealed a large left temporal lobe hematoma which extended medially to involve the left thalamus and posterior basal ganglia. Upon further examination, the patient was found to have injuries inconsistent with an accidental fall including a liver laceration, liver hematoma, and a pancreatic contusion.

Patient B:

Patient B was a 45-month-old African American female with no previous medical history. She was admitted to the hospital in the middle of June 2019 following a motor vehicle accident where she was ejected from the car. Patient B presented to the hospital with a right-sided subdural hematoma, multifactorial intracranial hemorrhage, pneumocephalus with multiple skull fractures and facial fractures, small left pneumothorax, and transverse process fracture of the second lumbar vertebrae. On the day of admittance, she underwent a craniectomy with a gastrostomy-jejunostomy tube and tracheostomy placement. Roughly 3 weeks later, the patient underwent an open reduction and internal fixation of her mandible with a closed reduction of her maxilla. Imagining revealed a multifocal hemorrhage involving the frontal lobes, increased density along the falx cerebri, narrowing of the ventricles, and the basilar cisterns.

Examination and Evaluation

Patient A:

Patient A was evaluated at bedside for inpatient rehabilitation 1.5 weeks after initial injury and did not attempt to verbalize when therapists performed the initial examination. Patient A demonstrated normal active upper and lower extremity movements; however, she exhibited right-sided neglect with more movements observed in her left upper and lower extremities than her right. Patient A resisted all passive range of motion attempts; therefore, tone could not be formally assessed. Negative clonus in bilateral ankles was noted.

Postural assessment demonstrated by Patient A revealed good head control, she was able to hold her head upright and in midline without external support and fair trunk control. Patient A was able to maintain static sitting balance at the edge of bed independently for roughly 15 seconds before requiring assistance to maintain posture. She required maximal assistance to maintain static standing balance. When in standing position, Patient A was primarily weight-bearing through her left lower extremity and maintained slight hip and knee flexion through her right lower extremity.

Table 1: Levels of Assistance Definitions

Assistance	Definition
Total Assistance (TotalA)	The child performs less than 25% of the task
Maximal Assistance (MaxA)	The child performs 25% to 49% of the task
Moderate Assistance (ModA)	The child performs 50% to 74% of the task
Minimal Assistance (MinA)	The child performs more than 75% of the task
Contact Guard Assistance (CGA)	The child requires one or two of the PT's hands to be placed on them for safety without any actual physical assistance
Stand by Assistance (SBA)	The child requires the PT to be close by incase physical contact needs to be made for safety concerns but does not actually require any physical contact
Supervision (Sup)	The child requires standby supervision with verbal cues or coaxing for safety, but the therapist does not need to be close to the child
Independent (I)	The child performs 100% of the task without assistance and without an assistive device

Patient A refused to participate in bed mobility assessments. Therefore, rolling, scooting, and supine to sitting transfers were not tested on the day of evaluation.

Patient A was able to follow simple one-step commands during the initial evaluation and responded with head nods to communicate yes and no. She was able to visually track and responded to both visual and auditory stimuli. Patient A's WeeFIM scores on initial evaluation were total assistance for all physical therapy categories.

Patient B:

Patient B was evaluated at bedside for inpatient rehabilitation 6.5 weeks after initial injury. She did not attempt to verbalize or vocalize when the initial assessment was performed. During the examination, Patient B exhibited normal active right upper and lower extremity movements. However, the movements in her left upper and lower extremity were minimal and abnormal. When a noxious stimulus was presented to the patient's bilateral upper and lower extremities, she withdrew both right and left extremities to avoid the stimulus. Patient B resisted movements for passive range of motion assessment in both upper extremities; therefore, tone could not be formally assessed. Increased tone and spasticity were noted at both ankles with the patient lacking 5 degrees of dorsiflexion from neutral. Exam results were positive for sustained clonus in her left ankle.

Postural assessment revealed poor head and trunk control. With full trunk support, Patient B was able to maintain her head upright and in midline for no more than 30 seconds before lowering her head into cervical flexion. Patient B was unable to maintain static sitting balance independently and required total assistance for all standing and sitting balance assessments.

Patient B was able to roll from supine to left sidelying but was unable to roll from supine to right sidelying. She required total assistance for all transfers and functional mobility. When assessing supine to sit transfer, she required total assistance to complete the transfer and demonstrated a full head lag when brought upright from supine.

Patient B was unable to follow simple one-step commands and did not respond to auditory or visual stimulus. She maintained a right-sided eye gaze and was unable to visually focus on or track a stimulus. Patient B's WeeFIM scores on initial evaluation were total assistance for all physical therapy categories.

Interventions and Performance Progression:

Patient A:

Week 1:

During week one, treatment interventions for Patient A focused on improving sitting and standing balance as well as increasing functional mobility. At the beginning of the week, Patient A was able to perform rolling transfers from supine to right and left sidelying with supervision but continued to resist weight-bearing activities through her lower extremities. As the week progressed, Patient A was able to maintain her balance during static and dynamic sitting activities with supervision. Additionally, Patient A demonstrated increased tolerance to weight-bearing during bouts of static standing. By the end of her first week, Patient A was able to ambulate distances of 15-25 feet with minimal assistance for balance. Though she continued to demonstrate right-sided hemiparesis, she showed increased purposeful movements of her right upper and lower extremities as compared to those documented in the initial evaluation assessment. The patient was able to achieve three goals during her first week in therapy; however, her WeeFIM scores remained the same from her initial evaluation at total assistance for all physical therapy categories **(Table 2).**

Patient A met the following goals during week one **(Table 4):**

- *Maintained static sitting balance for at least 15 minutes with stand by assistance.*
- *Transitioned from supine to sit with minimal assistance.*
- *Maintained static standing balance with upper extremity support with minimal assistance.*

Week 2:

Interventions during Patient A's second week focused on increasing her functional mobility and tolerance to therapeutic activities. She demonstrated the ability to transfer from sitting on the floor to standing with contact guard assistance. She was able to transfer into and out of an adult-sized chair with minimal assistance. She ascended and descended four steps using a non-reciprocal gait pattern with the use of the handrail and contact guard assistance. At the beginning of the week, Patient A was ambulating roughly 75 feet with contact guard assistance; however, by the end of the week, she was ambulating over 200 feet with stand by assistance. Patient A continued to demonstrate unsteady gait mechanics and decreased safety awareness during her ambulation bouts. The patient achieved numerous goals during her second week in therapy and her WeeFIM scores were changed to minimal assistance for transfers, supervision for walking, and moderate assistance for ascending and descending stairs **(Table 2)**.

Patient A met the following goals during week two **(Table 4)**:

- *Ambulated 25 feet with moderate assistance.*
- *Transferred from sit to stand from an appropriately sized chair with minimal assistance.*
- *Ambulated 150 feet with stand by assistance.*
- *Squatted down to pick up a toy and return to standing with stand by assistance.*
- *Transferred from floor to standing with stand by assistance*

- *Maintained dynamic standing balance while engaged in upper extremity activity for at least 5 minutes with stand by assistance.*

Week 3:

The third week of inpatient rehabilitation focused on age-appropriate, higher-level mobility tasks. At the beginning of week three, Patient A was ambulating roughly 500 feet with stand by assistance. She was able to ascend full flights of stairs with a reciprocal gait pattern with minimal assistance while using the handrail but used a non-reciprocal gait pattern to descend. When given visual and verbal cues to tandem walk on a 4-inch wide line the patient was unable to successfully complete the task without losing balance. By the end of the week, Patient A was ambulating over 1,000 feet with stand by assistance. She was also able to ascend and descend stairs with stand by assistance; however, she continued to use a non-reciprocal gait pattern. Patient A achieved numerous goals during her third week in inpatient rehabilitation and progressed to supervision for all physical therapy WeeFIM categories **(Table 2)**.

Patient A met the following goals during week three **(Table 4)**:

- *Ascended/descended 1 flight of stairs with the use of handrail and minimal assistance.*
- *Maintained single-leg stance without support for at least 3 seconds.*
- *Jumped forward at least 3 times in a row without loss of balance with stand by assistance.*

Week 4:

Patient A's last week of inpatient physical therapy focused on progressing developmentally appropriate gross motor skills and functional mobility. At the beginning of her last week, she was ambulating over 1,000 feet on level surfaces with stand by assistance. When taken outside to ambulate on unlevel surfaces, she required contact guard assistance due to impaired balance and decreased safety awareness. By the end of the week, Patient A was able to ambulate over 1000 feet on both level and unlevel surfaces with stand by assistance. She continued to show improvements in her balance and was able to self-correct when losses of balance were experienced. Patient A occasionally ascended and descended stairs with a reciprocal gait pattern and used the handrail but demonstrated a preference to ascend and descend with the non-reciprocal gait pattern. Patient A achieved one goal by the end of her last week in rehab. Her WeeFIM scores remained the same as her previous week, supervision for all physical therapy WeeFIM categories **(Table 2)**.

Patient A met the following goal during week four **(Table 4)**:

- *Ambulated over 500 feet on level and unlevel surfaces with stand by assistance.*

Discharge:

Patient A was discharged from inpatient rehabilitation services five weeks after her initial inpatient therapy evaluation. By discharge, Patient A was exhibiting bilateral upper and lower extremity movements that were within functional limits. Postural assessment demonstrated by Patient A revealed good head and trunk control. She was independent for both static and dynamic sitting balance and required supervision for static and dynamic standing balance.

Patient A was independent for all bed mobility assessments and required supervision for all transfers.

By discharge, Patient A was ambulating over 1,000 feet on level and unlevel surfaces with stand by assistance; however, she continued to demonstrate decreased safety awareness and impulsive behaviors during ambulation bouts putting her at risk for injury. She continued to navigate stairs with a preference for the non-reciprocal gait pattern and only occasionally demonstrated the reciprocal gait pattern. At discharge, Patient A's WeeFIM scores were supervision for all physical therapy categories **(Table 2)**.

Table 2: Patient A WeeFIM progression. Black: Nursing, Red: Physical Therapy, Green: Occupational therapy, Blue: Speech Therapy, Purple: Social interactions

	Admission	Week 1	Week 2	Week 3	Week 4	Discharge
Bowel	TotalA(1)	ModA(3)	Sup(5)	Sup(5)	Sup(5)	Sup(5)
Bladder	TotalA(1)	ModA(3)	Sup(5)	Sup(5)	Sup(5)	Sup(5)
Transfers	**TotalA(1)**	**TotalA(1)**	**MinA(4)**	**Sup(5)**	**Sup(5)**	**Sup(5)**
Ambulation (walk, wheelchair, crawl)	**TotalA(1)**	**TotalA(1)**	**Sup(5)**	**Sup(5)**	**Sup(5)**	**Sup(5)**
Stairs	**TotalA(1)**	**TotalA(1)**	**ModA(3)**	**Sup(5)**	**Sup(5)**	**Sup(5)**
Feeding	TotalA(1)	TotalA(1)	Sup(5)	Sup(5)	Sup(5)	Sup(5)
Grooming	TotalA(1)	TotalA(1)	MinA(4)	MinA(4)	Sup(5)	Sup(5)
UE dressing	TotalA(1)	TotalA(1)	MinA(4)	MinA(4)	MinA(4)	MinA(4)
LE dressing	TotalA(1)	TotalA(1)	Sup(5)	Sup(5)	Sup(5)	Sup(5)
Bathing	TotalA(1)	TotalA(1)	TotalA(1)	MinA(4)	MinA(4)	MinA(4)
Toileting	TotalA(1)	TotalA(1)	ModA(3)	MinA(4)	Sup(5)	Sup(5)
Tub Transfers	TotalA(1)	TotalA(1)	TotalA(1)	MinA(4)	MinA(4)	MinA(4)
Toilet Transfers	TotalA(1)	TotalA(1)	MinA(4)	MinA(4)	Sup(5)	Sup(5)
Memory	TotalA(1)	TotalA(1)	ModA(3)	ModA(3)	ModA(3)	ModA(3)
Problem Solving	TotalA(1)	TotalA(1)	ModA(3)	ModA(3)	ModA(3)	ModA(3)
Expression	TotalA(1)	TotalA(1)	TotalA(1)	MaxA(2)	MaxA(2)	ModA(3)
Comprehension	MaxA(2)	MaxA(2)	ModA(3)	ModA(3)	ModA(3)	ModA(3)
Social Interaction	TotalA(1)	TotalA(1)	MaxA(2)	MinA(4)	MinA(4)	MinA(4)
TOTAL RAW SCORE:	19	23	61	74	77	78

Patient B:

Week 1:

Interventions for Patient B focused on increasing postural control in sitting. She was able to maintain static sitting posture for 5-10 seconds with stand by assistance before losing her balance. She demonstrated an emerging but delayed protective extension reaction to her right side but did not exhibit a protective extension reaction to her left side. As compared to her evaluation, she was able to follow simple motor commands; however, she only used her right upper extremity when following the commands. At the beginning of the week, standing attempts with total assistance were trialed. During standing trials, she bore minimal weight through her right lower extremity and did not accept weight through her left lower extremity. To increase functional weight-bearing tolerance, the patient was placed in a full support pediatric stander. Bilateral ankle eversion was noted when standing. After all standing trails, sustained clonus was noted in her right ankle. By the end of week one, she demonstrated increased ability to transfer from supine to left sidelying with stand by assistance and transfer from supine to sit with modified assistance by using her right upper extremity to pull into a sitting posture. The time duration to maintain static sitting with stand by assistance remained unchanged at the end of the week. Additionally, throughout week one, Patient B was unable to visually track or respond to visual stimuli. The patient was able to achieve one goal during her first week in therapy and her WeeFIM scores remained the same from her initial evaluation at total assistance for all physical therapy categories **(Table 3)**.

The following goal was met by Patient B during week one **(Table 4)**:

- *Followed simple motor commands on 3/5 trials.*

Week 2:

The second week of inpatient rehab continued to focus on improving Patient B's postural control. Throughout the week, Patient B exhibited the ability to maintain static sitting posture for 20-second bouts with stand by assistance before requiring moderate assistance to maintain posture. Patient B required maximal assistance to maintain sitting balance when dynamic sitting trials were performed. She required varying levels of assistance from minimal assistance to maximal assistance to roll from supine to right sidelying and from sidelying to prone. When in the prone position, she required total assistance to correctly position her left upper extremity into a propped elbow position. While in prone, she was able to maintain her head upright and in midline independently. By the end of the week, she exhibited emerging visual ability to focus on objects in her right visual field but was not able to visually focus on objects in her left visual field. Patient B did not achieve any goals during her second week in therapy and her WeeFIM scores remained unchanged at total assistance for all physical therapy categories **(Table 3)**.

Week 3:

At the beginning of week three, Patient B was able to maintain static sitting while using her right upper extremity for balance with stand by assistance for up to 2 minutes. She demonstrated increased righting reactions and postural corrections throughout static sitting trials. However, Patient B still did not exhibit left protective extension. The patient was transferred into a modified quadruped position with total assistance. She was able to maintain a modified quadruped position with minimal assistance for roughly 20 seconds before losing balance. While in a modified quadruped position, she continued to exhibit increased weight-bearing through her right upper extremity as compared to her left upper extremity. While seated on a swiss ball to work on postural reactions, she demonstrated increased trunk and neck control when provided with postural perturbations and righting reactions when shifted laterally. At the end of the week, static standing was again trialed. With upper extremity support, she required total assistance of two to maintain her hips and knees in extension, and ankles in dorsiflexion to stand. By the end of the week, Patient B was able to maintain static sitting with stand by assistance for up to 7 minutes. During the third week, Patient B was able to achieve one goal; however, her WeeFIM scores remained unchanged at total assistance for all physical therapy categories **(Table 3)**.

The following goal was met by Patient B during week three **(Table 4)**:

- *Maintained static sitting balance with minimal assistance for at least 5 minutes.*

Week 4:

During week four, Patient B demonstrated an increased ability to maintain static sitting with stand by assistance for time intervals exceeding 10 minutes. Additionally, when in static sitting, left upper extremity protective extension emerged. Throughout the week, Patient B's tolerance to the modified quadruped position increased and she was able to maintain the position for up to 3 minutes with stand by assistance. By the middle of the week, Patient B was exhibiting the ability to transfer from supine to long sitting via right sidelying. She completed the transfer by pushing on her right upper extremity and using her core musculature. She was unable to complete the supine to sitting transfer from the left sidelying position. At the end of the week, Patient B was fitted with custom ankle-foot orthotics (AFOs) to increase dorsiflexion during standing trials with the upright stander. She met one goal during her fourth week in therapy, but her WeeFIM scores remained at total assistance for all functional mobility items **(Table 3)**.

The following goal was met by Patient B during week four **(Table 4)**:

- *Maintained sitting balance with stand by assistance for at least 10 minutes.*

Week 5:

During the fifth week of inpatient rehab, Patient B continued to demonstrate the ability to roll into right and left sidelying from supine with stand by assistance. By the end of the week, she also exhibited the ability to maintain static sitting with stand by assistance for over 15 minutes. Additionally, she maintained a sitting posture using her core musculature when postural perturbations were applied in all directions. Patient B achieved one goal during week five; however, her WeeFIM scores for all physical therapy categories remained at total assistance **(Table 3)**.

The following goal was met by Patient B during week five **(Table 4)**:

- *Rolled from supine to right sidelying with minimal assistance.*

Week 6:

Proper supine to sitting techniques were reinforced during her sixth week. The patient was again transferred to a modified quadruped position and was able to maintain modified quadruped while bearing weight through bilateral upper extremities equally for 2-minute intervals with stand by assistance. While wearing bilateral AFOs, standing trials were performed from an appropriately sized stool with upper extremity support. Initially, the patient required moderate assistance with upper extremity support to complete the sit to stand transfer. While in standing, she required moderate assistance to maintain her knees extended and hips forward in standing posture. After a few trials, she was able to stand for roughly 10 seconds with contact guard assistance at her hips before requiring increased assistance to maintain posture. By the end of the week, Patient B was able to maintain standing posture with upper extremity support for 30-45 second bouts with stand by assistance before requiring increased assistance to maintain standing posture. Patient B achieved one additional goal; yet, her WeeFIM scores remained at total assistance for all physical therapy categories **(Table 3)**.

The following goal was met by Patient B during week six **(Table 4)**:

- *Maintained a modified quadruped position for at least 30-second bouts with minimal assistance.*

Temporary Discharge:

The sixth week was Patient B's last full week of inpatient rehab due to her needing an airway reconstruction surgery for decannulation. For this surgery to take place, she was temporarily discharged from inpatient rehab and scheduled to resume inpatient rehab once medically cleared.

Table 3: Patient B WeeFIM progression. Black: Nursing, Red: Physical Therapy, Green: Occupational therapy, Blue: Speech Therapy, Purple: Social interactions

	Admission	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Bowel	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
Bladder	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
Transfers	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**
Ambulation (walk, wheelchair, crawl)	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**
Stairs	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**	**TotalA(1)**
Feeding	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
Grooming	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
UE dressing	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	MaxA(2)	MaxA(2)	MaxA(2)
LE dressing	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
Bathing	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
Toileting	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
Tub Transfers	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
Toilet Transfers	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
Memory	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
Problem Solving	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
Expression	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
Comprehension	TotalA(1)	TotalA(1)	MaxA(2)	MaxA(2)	MaxA(2)	MaxA(2)	Total(A)(1)
Social Interaction	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)	TotalA(1)
TOTAL RAW SCORE:	18	18	19	19	20	20	19

Outcomes:

Both patients received an hour of inpatient physical therapy daily, five days a week. Patient A was able to achieve all of her goals and improve her WeeFIM scores to requiring supervision for all physical therapy categories after five weeks. However, Patient B was unable to achieve the majority of her goals and her WeeFIM scores remained unchanged at total assistance for all physical therapy categories after six weeks. The raw WeeFIM scores were used to calculate each patient's developmental functional quotient. The average raw WeeFIM score for children between 53 and 55 months was 108.53 and the average raw WeeFIM score for children between 44 and 46 months was 101.00.[5] Patient A's developmental functional quotient was calculated to be 71.87%. This score indicates that at discharge, Patient A was performing at a functional level 28.13% lower than the average child her age. Patient B's developmental functional quotient was calculated to be 18.81%, indicating that she was performing at a functional level 81.19% lower than the average child her age at her temporary discharge date. According to studies performed by Suskauer et al. and Austin et al., DFQ scores greater than or equal to 85% were classified as good outcomes, scores between 70 and 84% were classified as moderate outcomes, and scores less than 70% were considered poor outcomes.[6,7] Therefore, at discharge Patient A and Patient

B were performing lower than their age-appropriate functional levels as determined by their DFQ scores and were considered to have moderate and poor outcomes respectively.

Table 4: Goals met by Patients A and B during inpatient rehabilitation **Denotes similar goals between Patient A and Patient B*

Week	Patient A	Patient B
1	• *****Maintained static sitting balance for more than 15 minutes with SBA***** • Transitioned from supine to sit with MinA • Maintained static standing balance with upper extremity support with MinA	• Followed simple motor commands 3/5 trials
2	• Ambulated 25 ft with ModA • Transferred from sit to stand from an appropriately sized chair with MinA • Ambulated 150 ft with SBA • Squatted down to pick up toy and return to standing with SBA • Transferred from floor to standing with SBA • Maintained dynamic standing balance while engaged in upper extremity activity for more than 5 minutes with SBA	*No goals were met*
3	• Ascended/ descended 1 flight of stairs with use of handrail and MinA • Maintained single-leg stance without support for more than 3 seconds • Jumped forward at least 3 times in a row without loss of balance with SBA	• *****Maintained static sitting balance with MinA for at least 5 minutes*****
4	• Ambulated over 500 ft on level and unlevel surfaces with SBA	• *****Maintained sitting balance with SBA for at least 10 minutes*****
5	*Patient was no longer in inpatient rehab*	• Rolled from supine to right sidelying with MinA
6	*Patient was no longer in inpatient rehab*	• Maintained modified quadruped position for at least 30-second bouts with MinA

Discussion:

This case report used the WeeFIM to compare the differences in functional mobility progression of two children with TBIs who presented similarly at baseline. The WeeFIM is a performance-based tool that evaluates a child's mobility, self- care, and cognitive abilities.[4] The WeeFIM is a validated instrument for typically developing children, children with developmental disabilities, and children who have suffered traumatic brain injuries.[4] This 18-item assessment grades the child's functional mobility on an ordinal scale from 1 to 7. The score assigned to each item reflects the level of independence obtained to complete each task.[8] Total independence is indicated by a higher score while lower scores indicate more assistance needed by the child. The degree of independence for each task varies depending on the developmental age of the child where children 7 years of age and older are expected to obtain full independence on all items.[8] The raw WeeFIM scores are converted to a developmental functional quotient (DFQ) to account for age-related differences. The WeeFIM DFQ describes a child's score as a percentage of those expected by age based on normative WeeFIM scores.[8]

Studies have examined various severity measures as predictive factors for determining the outcome of children with TBI. Such severity measures include the time from injury to admission into inpatient rehabilitation (TTA), the Glasgow Coma Scale (GCS), duration of post traumatic amnesia (PTA), total duration of impaired consciousness (TFC+PTA), and the time to follow command (TFC). Each severity measure provides valuable information regarding the impact the injury has on the patient's consciousness and functional abilities; however, each assessment also has its limitations with regards to the pediatric population.

A study by Kramer et al. examined the relationship between the time of injury to admission into inpatient rehabilitation (TTA) and functional status at discharge. This study examined 39 children between the ages of 3 and 18 who sustained a severe traumatic brain injury and who required total assistance on all WeeFIM categories at admission into rehabilitation.[3] The study found increased time between injury to admission was significantly correlated with worse functional status at discharge and at a 3 month follow up.[3] Additionally, a study by Rice et al. discovered that decreased time from injury to admission was associated with higher function on admission.[4] This study also evaluated how decreased time from injury to admission was significantly related to shorter length of stay in rehabilitation and how children with higher WeeFIM scores on admission required shorter lengths of stay.[4] Various research articles have used TTA as an indirect measure of injury severity with increased TTA being associated with increased injury severity since patients who are more medically complex require longer acute medical hospitalizations.[3,9]

The Glascow Coma Scale (GCS) defines an individual's level of consciousness following a traumatic injury.[10] It is a validated clinical assessment measure determining the severity and prognosis of individuals with TBIs.[7] The GCS assesses the level of consciousness based on visual, motor, and verbal responses.[7] Though the CGS has been shown to predict performance on neurophysiological testing both acutely and at long-term follow-ups, studies have shown that it does not significantly predict long-term functional outcomes on the WeeFIM in pediatric TBI patients.[3,6,7] Higher initial GCS scores significantly correlate with higher WeeFIM DFQ scores at discharge; however, research shows that GCS scores do not correlate with functional outcome scores at follow-ups after discharge.[3,7,11] Additionally, some studies have questioned the reliability of the GCS in pediatrics because the scoring system is based on the patient's ability to understand the commands provided in the assessment. This level of understanding to accurately score the GCS may not be applicable in the pediatric population.[12] To adjust for this, it has been suggested that the cut off score for severe traumatic brain injury be set at 5 in the pediatric population. Therefore, it is advised that the neurophysiologic dysfunction threshold be decreased in the pediatric population to account for this discrepancy.[13]

The duration of post traumatic amnesia (PTA) is defined as the duration in which patients with TBIs are unable to recall and store novel information. This inability to recall and store novel information reflects the disturbance in a patient's episodic memory following a severe head injury.[14] The Galveston Orientation and Amnesia Test (GOAT) which evaluates orientation and new learning through serially administered measures was developed to determine the end of PTA in children.[7,15] A study by Suskauer et al. defined PTA as the time from command following to the end of PTA while other authors define it as the entire time from injury to the emergence from PTA.[7] In the study by Suskauer et al., the total duration of time from injury to emergence from PTA is defined as time to follow command and post traumatic amnesia (TFC + PTA).[7] Independently, PTA was assessed to be a stronger predictor of memory test performance at 6 and 12 months post injury when compared to the GCS alone.[15]

In children, the total duration of impaired consciousness (TFC+PTA) is an important predictor for functional outcomes following a TBI.[7] Research by McDonald et al. found that TFC+PTA was a more accurate predictor of short and long-term neurobehavioral and functional outcomes than the GCS or TFC in a population of 6 to 18-year-olds.[16] Additionally, studies performed with younger patients found that TFC+PTA was also a significant predictor of functional outcomes when assessed with the WeeFIM and DFQ.[7] Yet, when comparing the predictive value of TFC+PTA to TFC alone, a study by Suskauer et al. found that TFC alone was a stronger predictor of WeeFIM outcomes at discharge from inpatient rehabilitation and at follow-up.[7] TFC is defined as the interval in days from injury until the patient is able

to follow simple one-step commands twice in a 24 hour period.[17] Research has indicated that children at the greatest risk for poor outcomes following a TBI are those who have a TFC greater than 26 days.[7,17] However, although a TFC greater than 26 days can be used as a predictor of poor long term outcomes, a TFC of 26 days or less is not an accurate predictor of positive outcomes.[7,17] The 26-day cut-off is used to identify children who have a higher likelihood of remaining severely impaired at a year follow up post-discharge.[6] Although studies have shown that TFC alone is a strong predictor of functional outcomes for children with TBI at discharge from inpatient rehabilitation and at a 3-month follow-up other studies have shown that TFC and TFC+PTA are strikingly similar in their ability to predict outcomes.[6,7,18]

Therefore, the disparities in functional progression and outcome scores between Patient A and Patient B in this case report could be a result of differences in their predictive severity measures. When severity measures are obtained at admission into acute care and inpatient rehabilitation a more comprehensive and accurate prediction for a patient's functional outcome can be made. When assessing the two patients in this case study, Patient A's TTA was roughly 1.5 weeks while Patient B's TTA was roughly 6.5 weeks. As previously discussed, longer TTA is associated with worse functional outcomes and is also used as an indirect measure of injury severity.[3,4] Patient B's TTA being much longer than Patient A's may indicate that her injuries were more severe. Additionally, Patient A was able to follow simple one-step commands at day of evaluation. However, Patient B was unable to follow simple one-step commands on admission day, roughly 42 days after the initial injury. Research suggests that TFC longer than 26 days is an indicator of poor long-term outcomes.[6] Understanding the severity measures that were available for each patient would have helped create more accurate predictions for each patient's functional outcomes. These predictions are useful when creating treatment plans and educating families on expected outcomes.

Conclusion:

In conclusion, severity measures such as the time from injury to admission into inpatient rehabilitation (TTA), the Glasgow Coma Scale (GCS), duration of post traumatic amnesia (PTA), total duration of impaired consciousness (TFC+PTA), and the time to follow command (TFC) are all useful for predicting functional outcomes in pediatric patients with TBI. Though some measures have proven to be more accurate predictors of functional outcomes all have been used in the research to help determine predictive outcomes.

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