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# Comparison of Functional Mobility Milestones and Associated Prognostic Factors Following Traumatic Spinal Cord Injury at an Inpatient Rehabilitation Facility: A Case Study

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## Abstract:

**Introduction:** The American Spinal Cord Injury Association (ASIA) developed the International Standards of Neurological Classification of Spinal Cord Injury (ISNCSCI) examination to inform treatment and prognostic decisions following spinal cord injury. Traumatic Spinal Cord Injuries (TSCI) are highly variable in their severity and presentations. The ASIA examination is one of the first and most important examinations done following TSCI. **Case Description:** This case study follows two patients' progress at an inpatient rehabilitation facility following a TSCI in regard to their physical therapy management. Patient A is a 19-year-old female with an ASIA A T8 Neurologic Level of Injury (NLI). Patient B is a 20-year-old female with an ASIA A T4 NLI. **Interventions:** Patient A and Patient B both underwent a comprehensive inpatient rehabilitation treatment program centered around task specific repetitive practice of functional mobility tasks. These tasks were taught, practiced, and continually evaluated throughout their inpatient rehabilitation care. **Outcomes:** Patient A and Patient B deviated in the amount of caregiver assistance that they required with their functional mobility tasks early. By week 1, Patient A was requiring just 50% caregiver assistance with bed to/from wheelchair transfers. At week 5, Patient B still required the same 50% caregiver assist with that same task. **Discussion:** Patient A and Patient B were similar in their age, NLI, demographics and social support. They deviated in their outcomes due to core muscle control, anthropometrics and neurorecovery. **Conclusion:** Comprehensive evaluations of TSCI patient beyond just NLI are required to make informed treatment and prognostic decisions following TSCI in an inpatient rehabilitation facility.

**Keywords:** traumatic spinal cord injury, inpatient rehabilitation, function, prognosis

**Purpose:**

Traumatic spinal cord injuries (TSCI) have unique progressions and manifestations on a case by case basis. Considering personal factors for an individual with a traumatic spinal cord injury may help make a more accurate functional prognosis that can help aid in their recovery. The purpose of this report is to compare and contrast two TSCI patients' functional recovery in an inpatient rehab facility.

**Introduction:**

TSCI vary widely in their classifications and presentations. The extent of a TSCI can range from mild sensory deficits in one extremity to complete loss of motor and sensory function in all four extremities. The umbrella term "TSCI" yields little information about the extent of an injury and the prognosis for rehabilitation. In order to gain more insight to the specifics of a particular spinal cord injury, the American Spinal Cord Injury Association (ASIA) developed the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) examination. This examination consists of a comprehensive evaluation of a patient's sensory and motor function throughout their entire body. Detailed sensory and motor information can provide a window into the status of the function of the spinal cord following a TSCI.<sup>1</sup>

The ASIA examination assesses 3 broad categories of function on both sides of the body: light touch sensation, sharp/dull distinction and motor function. Each of these functions is assessed at various spots on the body that correlate with dermatomes, myotomes and levels of the spinal cord. After completing the ASIA examination, patients with a TSCI will be classified into a Neurologic Level of Injury (NLI) that indicates the most caudal fully functional spinal cord level. Additionally, patients are classified into an ASIA impairment classification that demonstrates if all or some of the motor and sensory functions are impaired below the NLI. Knowing the NLI and ASIA impairment classification gives clinicians a detailed look into the extent of a TSCI, a patient's current level of function, and their prognosis for rehabilitation.

The NLI for a TSCI can vary from a level high in the cervical spine all the way down to a sacral or coccygeal level. In general, the more caudal NLI will have a greater functional prognosis as they have more of their normal bodily function intact.<sup>2</sup> The ASIA impairment classification has five different designations that are based on the completeness or incompleteness of a patient's injury at the NLI. ASIA A (complete) is a complete loss of sensory and motor function below the NLI. ASIA B (sensory incomplete) indicates sensory but not motor function is preserved below the NLI. ASIA C (motor incomplete) indicates some motor function preserved below the NLI. ASIA D (motor incomplete) indicates over half of the key muscle groups below the NLI have motor function. ASIA E (normal) indicates no sensory or motor deficits at or below the NLI following SCI.

The ASIA examination is often one of the first assessments done following a TSCI and is reassessed as needed throughout the plan of care to monitor the status of a patient's neurorecovery. The outcomes of this examination guide the treatment and prognosis decisions throughout the plan of care. At an inpatient rehab facility, the primary goal of physical therapy for all TSCI patients is to gain as much independence in functional mobility tasks as possible prior to discharge and prevent complications.<sup>3,4</sup> These tasks can vary depending on the individual patients and their goals. Functional mobility tasks become the center of all physical therapy interventions at an inpatient rehab facility and demonstrate the progress that patients have made throughout their stay. Closely examining these tasks can tell clinicians when a patient is ready to discharge out of the facility to resume physical therapy at an outpatient facility, home health or skilled nursing facility to continue their recovery.

While the ASIA examination is important for physical therapy care at an inpatient rehab facility of TSCI, it may not provide a complete picture of a patient's prognosis.<sup>5</sup> Traumatic spinal cord injuries (TSCI) have unique progressions and manifestations on a case by case basis. Considering factors beyond the NLI and ASIA impairment classification for an individual with a TSCI may help make a more accurate functional prognosis that can help aid in a patient's recovery.<sup>6</sup> The purpose of this report is to compare and contrast two TSCI patients' functional recovery in an inpatient rehab facility. Additionally,

this report will demonstrate the need for a comprehensive evaluation of an individual as a whole following TSCI in order to make more accurate and useful prognostic decisions.

**Case Description:***Patient A*

Patient A is a 19-year-old Caucasian female with no remarkable previous medical history. She presented to a university medical center following a motor vehicle accident as an unrestrained driver. Patient A's vehicle reportedly flipped and rolled over a 50-foot bridge causing her to suffer from apparent paraplegia with loss of movement and sensation to her bilateral lower extremities. Following the accident, Patient A had a L1 chance fracture, T12/L1 vertebral body fracture with anterolisthesis, left pterygoid Lefort III fracture, left apical pneumothorax, pulmonary contusions, left ribs 7-9 fractures, bilateral orbital fractures, and apparent neurogenic bowel and bladder. Patient A was taken to the operating room one day post motor vehicle accident for T12-L3 percutaneous fixation/reduction and open reduction internal fixation (ORIF) of bilateral Lefort III fracture. Following surgery, the patient was evaluated by a Physical Therapist and an Occupational Therapist and was determined to be an excellent acute rehab candidate and was transferred to an inpatient rehabilitation facility following her stay in acute care. The patient arrived at the inpatient rehab facility 14 days following her motor vehicle accident and 13 days following surgery.

Patient A was evaluated by physical therapy upon arrival at the inpatient rehab facility. She was determined to have an NLI of T8 and an ASIA impairment classification A. This means that Patient A had full strength and sensation in her arms down to the T8 dermatome and myotome near the mid-torso region. Since Patient A was an ASIA A, she possessed no sensation or trace muscle contractions below the T8 level. Patient A had no zones of partial preservation caudal to the NLI at initial evaluation.

*Patient B*

Patient B is a 20-year-old Caucasian female with no remarkable previous medical history. She presented to an emergency department following being thrown from a horse and loss of consciousness. Patient B underwent a CT scan that was negative for head/brain trauma but did display a T5/T6 fracture/dislocation injury. Patient was admitted to the hospital where she underwent a T4-T8 posterior thoracic stabilization with T6 laminectomy and decompression procedure. Following surgery, patient was evaluated by a Physical Therapist and an Occupational Therapist and was determined to be an excellent acute rehab candidate and was transferred to an inpatient rehab facility following her stay in acute care. The patient arrived at an inpatient rehab facility 9 days following her fall from a horse and 8 days following her surgery.

Patient B was evaluated by physical therapy upon arrival at the inpatient rehab facility. She was determined to have a NLI of T4 and an ASIA impairment classification A. This means that Patient B had full strength and sensation in her arms down to the T4 dermatome and myotome down in the mid to lower chest region. Since Patient B was an ASIA A, she possessed no sensation or trace contraction below the T4 level. Patient B had no zones of partial preservation below the NLI at initial evaluation.

At initial evaluation, Patient A and Patient B had no motor or sensory control of their legs and were considered to be paraplegic. Patient A and Patient B both underwent a comprehensive traumatic spinal cord injury rehabilitation program with physical and occupational therapy. At this inpatient rehab facility, the goals of physical therapy were to minimize complications and regain as much independence as possible with functional mobility tasks like bed mobility and transfers prior to discharging home with continued outpatient physical therapy. In the paraplegic population, functional mobility independence is one of the largest health related quality of life factors and thus is at the center of the rehabilitation process.<sup>7</sup> Interventions specifically targeting neurorecovery were used to supplement the functional tasks and were not necessarily the primary focus of their inpatient rehab physical therapy care.

**Interventions:**

Both Patient A and Patient B experienced the same progression of interventions at their own pace as necessary. Treatment began with extensive patient education on their diagnosis, prognosis and condition. Both of these patients had their upright tolerance assessed and addressed before they could begin more functional training. Next, passive range of motion and stretching of bilateral lower extremities was done to minimize complications and facilitate the necessary lower extremity mobility to aid in functional mobility tasks. Both of these patients had very good social support from their family that was able to be trained in passive range of motion/stretching to free up their time at physical therapy treatment sessions for more advanced interventions. In an effort to gain as much independence as possible and facilitate motor learning of novel functional mobility tasks, the primary intervention throughout Patient A and Patient B's inpatient rehab care was task specific repetitive practice of functional mobility tasks. There were 4 main areas of function that we demonstrated, educated and practiced daily in order to safely discharge these patients home. These tasks included bed mobility (rolling right and left, supine to and from sitting), bed to and from wheelchair transfers, car to and from wheelchair transfers and wheelchair negotiation and management (propulsion, ramps, curbs, and wheelies).

Each treatment session, Patient A and Patient B both worked to improve their independence and efficiency of these functional mobility tasks. Both patients were advised and cued to experiment with different strategies/techniques to figure out what works for them from the available options. Both patients were encouraged to tweak these strategies in their own unique ways as needed. Patient A and Patient B both required education on utilizing an anterior lean of their weight of their body to unweight their hips for transfers. This concept was continually utilized by these patients. Other strategies aimed at managing their lower extremities and maintaining safety throughout transfers were the focus of many hours of treatment sessions.

The same pool of interventions was utilized for both Patient A and Patient B. The difference in their plan of care manifested itself in the amount of assistance required from the caregiver as their inpatient rehab stay progressed. With functional mobility, Patient A and Patient B were given physical and verbal assistance from the caregiver as needed. Typically, the patients would require almost total physical assistance in the first few days and would progress to less physical assistance and more verbal cueing in its place after several weeks of practice. As each of these patients progressed, they required less and less caregiver assistance. The contrast in Patient A and Patient B was most evident in the amount of assistance that they each required throughout their plan of care. The timelines of Patient A's and Patient B's functional mobility recovery showcased how different these two cases really were despite appearing similar in their diagnosis.

**Outcomes:**

Each week, Patient A and Patient B were evaluated on their ability to perform the 4 core functional mobility tasks (bed mobility, bed to and from wheelchair transfers, car transfers, and wheelchair negotiation and management). Patients were graded on the amount of assistance that they required to perform these tasks. The grading scale listed in Table 1 was utilized consistently throughout each of their plans of care. This scale is largely based on subjective determination by the caregiver. The strength of this measure, in this instance, is that each of these patients were graded by the same caregiver every week. This creates a consistent and meaningful metric to gauge their progress.

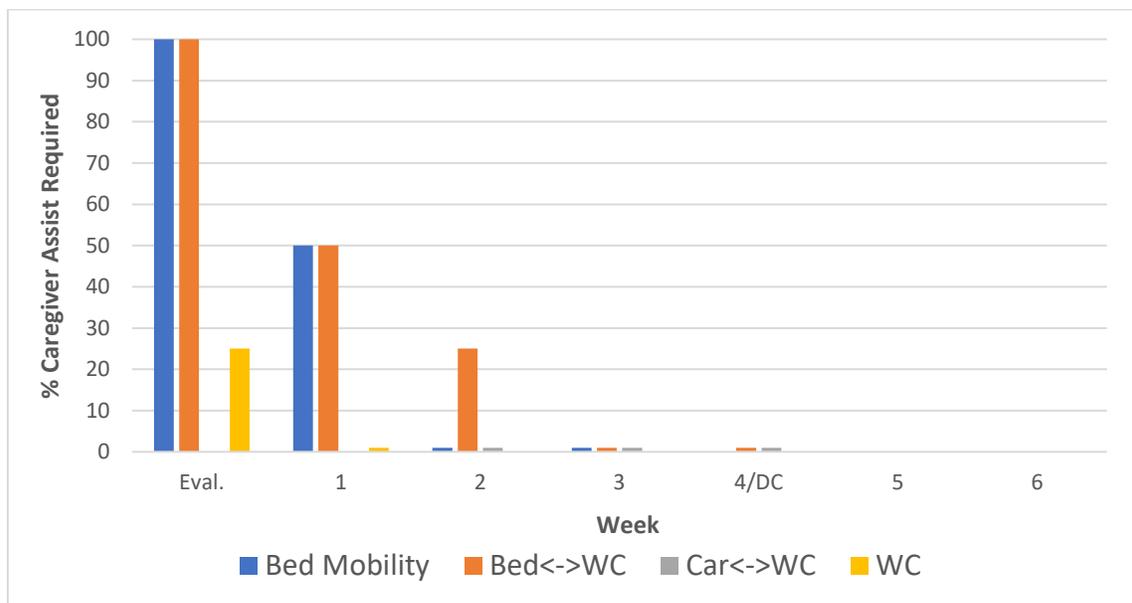
Figure 1A and 1B demonstrates the amount of caregiver assistance Patient A and Patient B required each week to complete their functional mobility tasks. Patient A quickly transitioned to performing these tasks with much less assistance than Patient B. This same pattern between Patient A and Patient B with the amount of assistance required to complete their functional mobility tasks stayed fairly consistent throughout their inpatient rehabilitation plans of care.

For example, Patient A was requiring just 50% assistance with bed to and from wheelchair transfers after just 1 week. At week 5, Patient B was still requiring that same 50% assistance for this transfer. Additionally, the car transfer was generally introduced after several weeks of refining their slide board

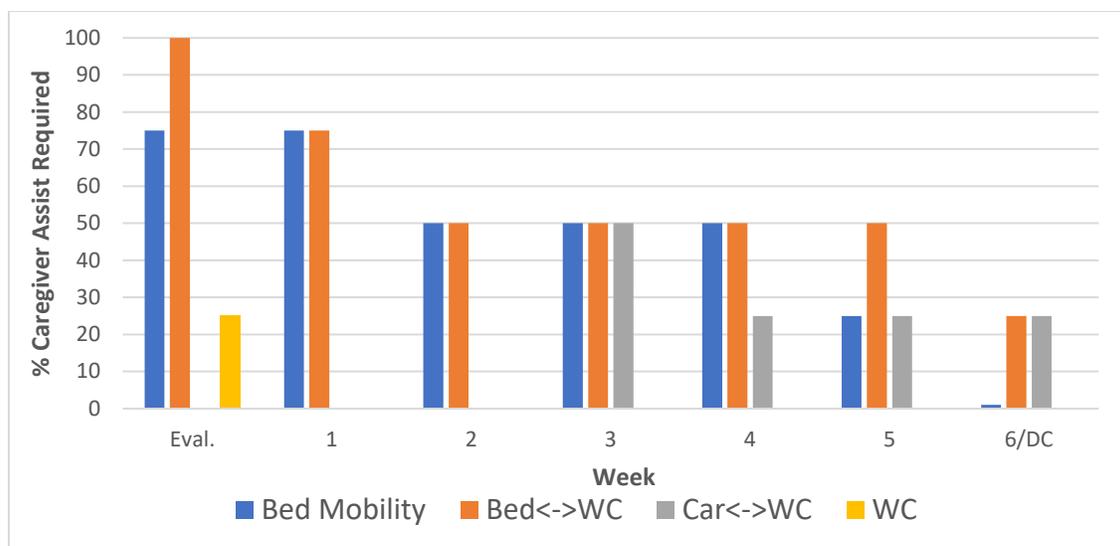
transfer technique on the mat table or bed. At week 2, the first week that Patient A was evaluated for car transfers, she was already at supervision (1%) caregiver assistance for the task. At week 6/discharge, Patient B was still requiring 25% caregiver assistance for car transfers. Even with all that these patients had in common with demographics, diagnosis, social support and interventions, the amount of assistance that they required to complete the various functional mobility tasks deviated in a way that was difficult to ignore.

**Table 1:** The assistance level assigned during functional mobility tasks and the percentage of assistance cut off values associated with it.

Assistance level	Percentage
Supervision	1%
Minimal	25%
Moderate	50%
Maximal	75%
Total	100%



**Figure 1A:** Patient A's week by week progression of the amount of caregiver assistance required to complete her functional mobility tasks. Patient A discharged at week 4.



**Figure 1B:** Patient B's week by week progression of the amount of caregiver assistance required to complete her functional mobility tasks. Patient B discharged at week 6.

### Case Comparison and Discussion:

Due to Patient A and Patient B both having middle/upper thoracic NLI complete TSCI, their long-term functional prognoses were similar. Both patients should have full use of their upper extremities to assist with transfers, wheelchair mobility and bed mobility. Both patients should have some but not all of the use of their abdominal/core muscles. Both patients are unlikely to ambulate on their own due to loss of lower extremity function. While Patient A and Patient B will likely end up getting to complete independence with functional mobility tasks at some point, their timelines and progressions to get to that point will not be uniform.

On the surface, Patient A and Patient B appear to be extremely similar in their demographics, diagnosis, and prognosis. Over the course of their inpatient rehabilitation stays, they both progressed at very different rates. The differences in their functional mobility progression may be attributed to several factors. Examining Patient A and Patient B in more detail beyond just their NLI and ASIA impairment classification provides a clearer picture into why their inpatient rehab stays played out so differently.

#### *Core Musculature Control*

Patient A and Patient B both had full use of their upper extremities following their injuries. Both patients had complete motor and sensory loss of their lower extremities. The difference in their neuromuscular control is seen only in the core/abdominal region. While the core/abdominal muscle region has been shown to be important in respiratory health following SCI, the postural stability implications cannot be ignored.<sup>8</sup> To say that both of these patient's had some but not all of their core muscle control/function would be a gross oversimplification. The differences in these patients' core control was likely a major differentiator in their functional mobility timelines noted above.

At an NLI of T8, Patient A likely had control over the core muscles all the way down to her belly button region. With zones of partial preservation at discharge down to L1, Patient A's core musculature control likely allowed her to become less reliant upon her upper extremities for seated balance control. This freed up her upper extremities to be more readily available for functional mobility tasks like transfers, bed mobility and wheelchair management.

Patient B's NLI of T4 demonstrates that she likely had control of very little core musculature below her nipple line region. Patient B had to rely on her upper extremities for seated balance alone. This caused Patient B to have less availability of her upper extremities for functional mobility tasks. Patient B

had to be much more deliberate with how she positioned her upper extremities for seated balance support while also utilizing her upper extremity function for mobility. Significantly less core muscle control is likely a major reason why Patient B took longer to learn and perform functional mobility tasks with less assistance than Patient A.

### *Anthropometrics*

Anthropometrics may have contributed to the differences in functional mobility tasks between Patient A and Patient B. While anthropometrics have been used to demonstrate bone and muscle volume following SCI, they may also play a role in functional mobility tasks.<sup>9</sup> Patient A was 5'3" 141 lbs at initial evaluation following her injury. She was an ectomorph body type and carried a lower percentage of her bodyweight in her lower extremities. Patient A had a more biomechanically advantageous body weight distribution that allowed her upper extremities and core to more easily manage the position and weight of her lower extremities during functional mobility tasks.

Patient B was 5'2" 172 lbs at initial evaluation. She was an endomorph body type that carried a larger percentage of her body weight in her lower extremities. Patient B had more weight in her lower extremities to manage than Patient A. Having to manage this larger weight on top of having less core muscle control created a unique and more difficult challenge for Patient B compared to Patient A.

### *Neurorecovery*

While neurorecovery wasn't a specific priority with both of these patient's inpatient rehab care, interventions targeting neurorecovery were done to supplement their usual functional mobility practice. Activity based interventions have been shown to aid in the neurorecovery process.<sup>10</sup> The status of their neurorecovery was measured and analyzed at the inpatient rehab discharge ASIA examination. At the initial evaluation, Patient A had a NLI of T8. By discharge 4 weeks later, Patient A had an NLI of T10 with zones of partial preservation down to L1. On the other hand, Patient B had an NLI of T4 at the initial evaluation and 6 weeks later at discharge with zones of partial preservation down to T6 at discharge.

Both Patient A and Patient B experienced some neurorecovery during their inpatient rehab care. Patient A's NLI actually lowered down to T10. This caudal movement of Patient A's NLI likely exacerbated the differences in Patient A and Patient B's abdominal/core musculature control as previously discussed. Neurorecovery and the migration of the NLI for Patient A and Patient B likely contributed to the differences noted in their functional mobility tasks during their inpatient rehab care.

### *Complications and Comorbidities*

While Patient A benefited from increased core musculature control, neurorecovery and more manageable anthropometrics, she also separated herself from Patient B with other complications and comorbidities. Patient A had better tolerance to upright, less spasticity, greater hip passive range of motion, less pain and less fear of falling. All of these factors worked in Patient A's favor when it came to her ability to practice and perform functional mobility tasks. Patient B's tolerance to upright, spasticity, hip passive range of motion, pain and fear of falling undoubtedly contributed to her slower progress with functional mobility task independence. She was not able to devote as much time to practicing these tasks as Patient A due to having to dedicate more physical therapy treatment sessions to personal factors, comorbidities and complication management than Patient B had to.

In order to make sense of the discrepancies seen with Patient A and Patient B's inpatient rehabilitation outcomes, one must more closely examine their comorbidities throughout their plan of care. When working to achieve greater independence and functionality following TSCI and subsequent paraplegia, everything, even small comorbidities that are easy to overlook, should be considered to inform treatment and prognostic decisions to better care for TSCI patients. It is the duty of physical therapists to leave no stone uncovered when evaluating TSCI patients in order to individualize their plan of care and treatments.

**Conclusion:**

This case report advocates for the completion of a comprehensive and thorough evaluation and plan of care for TSCI patients in an inpatient rehabilitation facility. A comprehensive and thorough evaluation and plan of care should consider NLI, anthropometrics, neurorecovery and other characteristics/comorbidities unique to the individual in order to develop a proper prognosis. Patient A and Patient B had similar injuries, demographics, prior level of function and inpatient rehabilitation care. At a glance, it would be easy to lump them into similar prognoses with their functional mobility tasks while at inpatient rehabilitation. Having the privilege to work closely with both Patient A and Patient B throughout their entire stay at inpatient rehabilitation, it was easy for me to see how complex a TSCI case can be. This case study demonstrates that there is much more to consider than the NLI when establishing a prognosis and plan of care for TSCI patients. Developing a proper prognosis can influence patient expectations, treatment decisions, payer decisions and ultimately can lead to better outcomes for the patient. Treating each patient on a case by case basis and considering their unique characteristics will allow the Physical Therapist to provide the best care possible for the patient.

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