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Functional Recovery in a 67-Year-Old Male with Staphylococcus Aureus Spinal Cord Abscess: a Case Report

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FUNCTIONAL RECOVERY IN A 67-YEAR-OLD MALE WITH *STAPHYLOCOCCUS AUREUS* SPINAL CORD ABSCESS: A CASE REPORT

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Abstract

BACKGROUND AND PURPOSE: While infections are common and typically easy to treat, they can have serious implications when they occur near the spinal cord. Spinal epidural abscess (SEA) is a diagnosis rarely reported in the physical therapy (PT) literature. The purpose of this case report is to describe the course of inpatient PT treatment and functional gains for a patient with a SEA caused by *S. aureus* infection.
CASE DECSRIPTION: The patient was a 67-year-old male with a diagnosis of C3 tetraplegia, ASIA C classification, as a result of a SEA at C3-4. Prior to the onset of symptoms related to the SEA, he was in good health with no serious co-morbidities and completely independent in activities of daily living (ADL) as well as instrumental activities of daily living (IADL). During his seven week inpatient stay, the patient participated in treatment 5-7 days per week. Interventions fell into the following categories: transfers, mobility and ambulation, strengthening, balance, endurance, manual stretching, soft tissue mobilization, and modalities for pain control. Interventions were progressed with increasing difficulty and decreasing assistance in all categories according to patient performance.
OUTCOMES: Over the course of treatment, the patient was able to progress from total assist for transfers and all functional mobility to modified independence for transfers and community ambulation with a four wheeled walker.
DISCUSSION: Despite having a cervical SEA, which is correlated with poorer motor outcomes, the patient demonstrated rapid and meaningful functional gains. While this result supports previously reported potential for functional recovery, the patient's level of injury and delayed motor return make his case unlike others in the literature. Although gold standards for medical and surgical techniques are well represented in the literature, there is a lack of PT-related literature concerning SEA. Conflicting evidence has been reported regarding motor improvements following rehabilitation for patients with SEA. Areas for further research exist in the realm of PT as well as quality of life outcomes following SEA.

RESEARCH ADVISOR APPROVAL FORM

The undersigned certify that they have read, and recommended approval of the research project entitled…

FUNCTIONAL RECOVERY IN A 67-YEAR-OLD MALE WITH *STAPHYLOCCOCUS AUREUS* SPINAL CORD INJURY: A CASE REPORT"

submitted by

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in partial fulfillment of the requirements for the Doctor of Physical Therapy Program

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Introduction

Formation of an abscess occurs when invasion of a bacterial agent causes a collection of dead neutrophils, commonly known as pus, to form in an area of the body.[1] While the process of abscess formation is relatively benign, compression on surrounding structures can occur and cause a disruption of the function of adjacent tissues. Abscesses can form in any area of the body including the skin, peritoneal space, abdominal organs, connective tissue and muscle as well as in nervous tissue. *Staphylococcus aureus* (S. aureus) is a common bacterial cause of abscesses in humans due to the radical response of the immune system to the invasion of this agent.[2] Additionally, humans are natural hosts with 30-50% of the population having some level of *S. aureus* colonization which increases the risk of subsequent infection. The existence of new antibiotic resistant strains of S. aureus necessitates the use of aggressive antibiotic therapy with potent medications.

When abscesses form in or near the spinal cord, significant signs and symptoms can arise and should be addressed promptly. Locations of spinal cord abscesses that have been reported in the literature include: intramedullary, subdural, and epidural.[3-6] Epidural abscesses are the focus of this report. Risk factors for spinal epidural abscess (SEA) have been reported by multiple sources and include: diabetes mellitus, trauma or abnormality of the spine, intravenous drug use, cancer, AIDS, alcoholism, chronic renal failure, and long term corticosteroid therapy.[7,8] Mean age range for onset of SEA has been reported as 40-60 years of age[9] and 50-70 years of age[7]. *S. aureus* is the most common cause of

SEA in humans and is implicated in 60-90% of cases.[10] Merrell et al[9] reported a similar but slightly lower incidence rate of *S. aureus* infection (61-73%). Approximately 50% of spinal epidural abscess cases occur secondary to spread of a primary skin, soft tissue, urinary or respiratory tract infection.[7] These rare, but serious, secondary infections account for 2.5-3 per 10,000 hospital admissions.[7]

Primary signs and symptoms of SEA are progressive and include back pain, fever, tenderness over the infection site, bowel and bladder dysfunction, radicular pain, sensory abnormalities and paresis or paralysis.[7,9] There is some disagreement in the literature regarding the incidence of SEA at different levels of the spinal cord. Merrell et al[9] cites the lumbar spine as the most common site of infection while Alvarez[10] reports that the thoracic spine is most commonly affected. These sources do agree, however, that the cervical spine is least often implicated. Undiagnosed, SEA can lead to serious consequences including paralysis and death. Conflicting information has also been reported regarding overall mortality rate in the SEA population. Alvarez[10] reports an overall mortality rate of 13-15% while Sendi et al[7] and Soehle et al[8] report even greater ranges of 2-20% and 5-32%, respectively. Reishaus et al[11] conducted a meta-analysis of 915 SEA patients presented in the literature. The authors reported that mortality rates decreased drastically until about 1980, at which time rates stabilized between 13% and 16%. It was suggested that differences in reported mortality rates are due to the location of abscesses, extent of neurological involvement, period of time being reported, as well as treatment modalities.

Medical and surgical management of SEA is well represented in the literature.[3,7,8,10] A multi-modal approach to treatment including surgical decompression or laminectomy, drainage of the abscess, and extended antibiotic therapy is the gold standard. The literature on SEA has been primarily focused on diagnosis, medical treatment, and survival rates. Only a few reports of SEA mention referral to neuro-rehabilitation and the importance of physical therapy (PT) intervention.[4,10] Despite the report that nearly one in three patients with SEA develop paresis or paralysis and up to 1/3 of patients are unable to ambulate independently following a SEA[11], there is a void in the literature regarding PT intervention and outcomes for rehabilitation in this patient population. A possible explanation for this gap in the literature could be the reported rate of complete recovery from SEA, which was estimated by extensive review of the literature by Reihsaus et al[11] to be between 41-47% since the 1950's. Similar complete recovery rates are cited in retrospective reports by Weinegarden et al[12] and Soehle et al.[8] Soehle[8] reported that among patients with SEA, 60% demonstrated good motor outcomes characterized by minimal or no neurological deficits while the remaining 40% of surviving patients were found to have poor motor outcomes.

Of the group of patients with residual neurological deficits, SEA located in the cervical spine was found to be prognostic of poorer outcomes, as were low leg muscle strength grades at admission.[8] While no report of specific rehabilitation parameters could be found specifically for the SEA population, it stands to reason that these patients are likely being treated similarly to other patients with spinal cord injuries. Depending on level of

injury and level of motor sparing (complete versus incomplete), a combination of rehabilitative and compensatory techniques have historically been utilized in order to help patients return to ambulation.[13]

Koo et al[14] conducted an age-matched comparison of motor outcomes after rehabilitation in patients with SEA and incomplete traumatic spinal cord injury (TSCI). The authors found statistically significant difference in improvement in motor ability in the SEA group versus the TSCI group, despite the SEA group starting with lower initial motor scores and higher average age. Additionally, the authors reported that conversion from a motor complete (ASIA A or B) to a motor incomplete (ASIA C or D) occurred in 76% of the SEA cases, compared with only 32% in the TSCI group. In a similar retrospective study of ASIA classification and lesion level-matched SEA and TSCI patients, Zafonte et al[15] reported drastically different findings. In this study, those patients with TSCI experienced double the increase in FIM scores from rehabilitation admission to discharge (average increase of 30 versus 15 in the SEA group).[15]

Another recent retrospective review supports the findings of Zafonte et al. McKinley et al[16] found that while length of inpatient rehabilitation stay was similar between groups, FIM motor changes were lower for patients with SEA (16.2 versus 22.8 for TSCI). In addition, patients with SEA in this study were less often discharged home than those with TSCI. These findings underscore the need for further development of the knowledge of SEA-related treatment and potential for functional improvement among rehabilitation

professions. While it is unclear whether there is a true difference between potential for motor recovery between SEA and TSCI patient populations, the current evidence indicates that SEA-induced spinal cord injuries (SCI) have different characteristics than TSCI and may necessitate different parameters for treatment and rehabilitation.

The purpose of this case report is to describe the course of PT treatment and functional gains for a patient with a SEA caused by *S. aureus* invasion, a diagnosis rarely addressed directly in the PT related literature. This case report meets the clinical institution's requirements of the Health Insurance and Portability and Accountability Act for patients' health information. The patient provided written informed consent for inclusion in this case report (Appendix A).

Case Description

The patient was a retired 67-year-old male with a diagnosis of C3 tetraplegia, ASIA C classification, as a result of a SEA at C3-4. Prior to hospital admission the patient was in good health and performed all ADL's and IADL's independently. He enjoyed working in the yard and around the house, tending to the herd of cattle on his hobby farm, going to visit with friends at a local coffee shop and spending time with his wife, children and grandchildren. According to the admitting physician's notes, two days prior to admission, the patient awoke early and was unable to move his right side. The patient also reported having pain in his upper back the night before which he treated with over the counter pain medication. He was immediately brought to the emergency room by his wife and treated by the hospital staff as if he had experienced a left-sided CVA. Upon imaging, a CVA was ruled out. However, a C3-4 paraspinal abscess was discovered with significant invasion of the thenar sac, which surrounds the spinal cord. No risk factors for SEA were identified. The patient was immediately transferred to a nearby hospital where a C2-6 decompression laminectomy was performed. During the acute hospital stay, serology revealed that *S. aureus* was the bacterial agent responsible and the patient was started on an aggressive series of nafcillin via PICC line. One week after the initial diagnosis and following stabilization of his medical status, the patient was transferred to the inpatient rehabilitation unit (IRU) for continued medical care and intensive antibiotic treatment as well as physical and occupational therapy. The admitting physician's notes indicated that the patient presented with a neurogenic bowel and bladder.

Examination

The patient was examined by one of the staff physical therapists one day after he was admitted to the IRU. Standard physical therapy examination of patients in the IRU is based upon FIM scoring and includes categories such as transfers, ambulation, wheelchair mobility where applicable, stairs, range of motion, strength, and neurological deficits.

The Functional Independence Measure (FIM) is a commonly used performance measure used primarily in the IRU to describe patient functional ability. Patients are rated on their ability to perform 18 tasks including 13 motor and 5 cognitive items.[13] Professionals from many disciplines, including physical therapy, are able to score the 18 items on a 7-point ordinal scale ranging from 1, complete dependence, to 7, complete independence.[17] Written definitions of the FIM scale can be found in Appendix B. Van der Putten[18] investigated the FIM and found it to be responsive to change in patients with stroke and multiple sclerosis. The FIM cognitive scale, however, was shown to have a significant ceiling effect when used with patients who did not have primary cognitive involvement.[18] FIM scoring has been found to have excellent inter-rater reliability (total FIM ICC=0.96) when completed in the rehabilitation setting by trained assessors.[19]

A unique feature of the FIM scoring system is the designation of modified independent status, indicating the need for increased time to complete tasks or the presence of concerns for safety while performing activities. FIM scores are reported as a total score

or as individual scale scores. The ordinal scoring is also commonly used as a means of daily monitoring for level of assistance needed for motor and cognitive tasks. Table 1 describes the patient's scores in the above categories upon initial evaluation.

Table 1. Examination categories and scores upon admission.

Category	Comments	Admit Score
Transfers	Slide transfer with mod A of 3 to chair	1
Toilet	Pt unable to access commode at this time. Foley catheter and attends in place	0
Ambulation	Standing attempted with max assist of 2; pt. unable to assist	1
W/C mobility	Not tested	0
Stairs	Not tested	0
ROM	PROM of bilateral UE and LE tolerated well. Functional AROM: L UE to mouth, R UE unable. L hip flexion > R hip flexion, both less than 15 degrees.	
Strength	Pt. unable to assume MMT positons. Grossly at least 1/5 muscle strength through bilateral UE and LE. Muscle contraction noted greater on L.	
Neurological Deficits	No clonus present. Sensation intact bilateral UE and LE.	

Mod=moderate; A=assist; pt=patient; PROM=passive range of motion; max=maximum; L=left; UE= upper extremity; LE=lower extremity; MMT=manual muscle testing.

Evaluation

IRU evaluation documentation indicated that the patient presented with post-surgical pain in the posterior cervical region, impaired functional mobility (per the FIM), decreased AROM (per observation), inability to ambulate, decreased extremity strength assessed by the use of standard manual muscle testing, impaired balance as a result of decreased trunk

strength, decreased activity tolerance and edema in the right lower extremity per observation. The patient was expected to return home with his wife in 4-6 weeks with additional help for ADLs as needed provided by a personal care attendant. Due to his need for continued IV antibiotics, in-home nursing and PT services were recommended following discharge home. The patient's impairments and functional limitations were consistent with the *Guide to Physical Therapist Practice*[20] preferred practice pattern 5D: Impaired Motor Function and Sensory Integrity Associated with Nonprogressive Disorders of the Central Nervous System - Acquired in Adolescence or Adulthood.

Prognosis

Due to the location of the SEA in the cervical spine[8], lack of immediate recovery of motor function following surgical intervention, and in light of the active lifestyle he led before his hospitalization, prognosis for full return to his prior level of function was determined to be poor at the time of evaluation. In the short term, it was expected that the patient would be able to return to living at home with his wife with the assistance of personal care attendants for completion of ADLs and functional mobility within the home. The patient appeared to be motivated to return to independent mobility as well as his family roles and household responsibilities. Long term, it was expected that the patient would primarily utilize a power or power-assist wheelchair for community mobility. Due to the level of dependence at the time of admission, it was unclear whether the patient would recover his ability to ambulate functionally.

Intervention

During the 43 days the patient was in the inpatient unit, he participated in both OT and PT each day. PT sessions lasted between 30 and 60 minutes and occurred either once or twice during the day depending on scheduling and day of the week. Monday through Friday the goal was for 90 minutes each of OT and PT (accounts for 31 days of treatment). Saturday and Sunday were typically reserved for rest and activities with lower intensity and account for 12 days of the inpatient stay. During weeks one and two, interventions were focused on functional training for transfers and strengthening of the trunk and lower extremities. Starting in week 2, decreased activity tolerance was addressed by increasing unsupported sitting time and through the use of the NuStep† recumbent exercise machine as well as through the progression of ambulation to include long distances without rest breaks. Additional treatment categories are listed below. A complete list of interventions by week can be found in Appendix C.

Transfers

During the first two weeks of treatment, the patient utilized a slide board for transfers between surfaces and needed maximum assist of either one or two. Supine to sit and sit to stand transfers were also maximum assist of one or two. While large portions of treatment time were rarely devoted to practicing transfers, the patient was instructed to

†NuStep Domestic Distributor 5111 Venture Drive Suite 1 Ann Arbor, MI 48108

assist as much as possible during each positional change. Stand pivot transfers were addressed more thoroughly during treatment due to the patient's tendency to sit in an uncontrolled manner, posing a possible safety risk for both himself and hospital staff. As the patient gained strength and confidence, manual assist was decreased and replaced with verbal cues. Verbal cues were offered more often at first then decreased in order to allow for patient self-correction and motor learning. At discharge, the patient was able to perform all transfers with modified independence, as he utilized bed rails and needed increased time to complete tasks.

Mobility and Ambulation

On day five, a power chair with joystick control was introduced. The patient was unable to operate the joystick control with his right hand but was independent for community distances (greater than 150 feet) when the control was switched to the left hand side. As strength and endurance were gained over the first two weeks, standing activities were incorporated in week 3 and quickly progressed to stepping activity and gait in the parallel bars. Over-ground gait-training was initiated on day 12 of the inpatient stay. A front wheeled walker (FWW) was prescribed initially as the patient displayed the need for bilateral support and possessed adequate hand function to grasp the walker with both hands. Between the initiation of gait training in week three and discharge in week seven, walking was progressed in distance from 50 feet with moderate assist and rest breaks to 1000+ feet modified independent without breaks. Different surfaces were also utilized for gait training as the patient progressed, beginning with flat, firm surfaces indoors and

advancing to variable surfaces both indoors and outdoors. Gait training was initially performed in the relatively quiet IRU hallways and PT gym and advanced to busier environments like the unpredictable hospital hallways and visitor areas. Finally, ambulation on a treadmill was used to allow for increased distance and speed parameters during gait training as well as retro-walking.

Strengthening

Strengthening began immediately after admission to the IRU. The patient presented with less than antigravity strength in all four extremities, with greater activation noted on the left (Table 1). Supine upper and lower extremity exercises to address prime movers of the shoulders, hips, and knees were initially performed with manual resistance. As strength and endurance improved, exercises were progressed by changing position or support surface or by increasing the number of repetitions completed. Body weight, manual resistance, or small weights were used as resistance. Even as the patient gained strength, seated lower extremity exercises continued to be used in favor of conserving energy for ambulation and more difficult balance activities in standing. Refer to Appendix C for more detail.

Balance

Interventions aimed at improving balance began in the second week of IRU treatment. The initial focus of balance activities was stationary activities such as sitting unsupported on the treatment mat in order to allow for upright positioning. As the patient gained

strength and activity tolerance, stationary sitting activities were progressed to dynamic sitting activities such as reaching in diagonals. Further strength increases allowed for progression to static and dynamic standing activities. Gym-based balance activities included weight shifting in various positions, unsupported double- and single-leg stance, dynamic activities in standing, and reaching for cones at variable heights and distances from the patient's center of gravity. As an alternative to gym-based balance activities, a Nintendo Wii† game console and the WiiSports bowling game were used during weeks four through seven.

Other

Through the course of treatment, the patient complained of minor muscle soreness and tightness in the mid thoracic region, posterior neck musculature and foot intrinsics. Soft tissue mobilization techniques and superficial cold modalities were utilized to address these issues as they arose. Also, approximately once per week the patient requested passive LE stretching. Stretching of the hamstrings, deep hip rotators and plantarflexors were performed 1-2 times each using 30-60 second holds. As the patient's strength and AROM improved, he was encouraged to participate in stretching activities as much as possible.

†Nintendo Domestic Distributor 2525 N. 7th St. Harrisburg, PA 17110

Outcomes

Through the course of treatment, goals were set on a weekly basis and continually re-assessed. Due to the patient's presentation and prognosis for return to function, goals were initially set conservatively. The patient quickly began to meet the goals and they were progressed in order to reflect appropriate challenges. A number of PTs on the rehabilitation team and a PT student were involved in determination of appropriate goals. Weekly goals and progress can be seen in Table 2.

FIM scores were used for daily and weekly monitoring of the patient's functional status. Table 3 describes the patient's motor scale FIM scores and other evaluation criteria at the time of discharge from the IRU.

Transfers

At the time of discharge, the patient was completing all bed mobility and transfers either independently or independently with the use of assistive devices (modified independent). The patient was able to manage his own IV line during functional mobility, an important ability given the need for continued IV antibiotics at home.

Table 2. Patient goals over the course of treatment.

Week	Goals	Goal Met?
1	Pt will be able to touch forehead with L UE. Pt will perform heel slides bilaterally with knee flexion to 45˚ in supine. Pt. will tolerate sitting on mat with min A for 3 minutes.	NO NO NO
2	Pt will be able to touch forehead with L UE. Pt will perform heel slides bilaterally with knee flexion to 45˚ in supine. Pt. will tolerate sitting on mat with min A for 3 minutes.	YES YES YES
3	Transfer Min A-SBA. Gait 20 ft with FWW—met early in week, new goal below. Gait 150 ft with FWW mod-min A.	YES YES YES
4	Gait 150 ft consistent SBA with FWW. Mod I with manual W/C mobility 150 ft. Ascend/descend 3 steps with one rail SBA.	NO—CGA YES NO—Min A
5	Gait 150 ft consistent SBA with FWW. Ascend/descend 3 steps with one rail SBA.	YES YES
6	Gait 150 ft with 4WW and Sup over all surfaces. Sup for all functional transfers. Gait 50 ft with NBQC and Sup. Assess appropriateness of AFO for R LE.	YES YES YES YES
7	Mod I all transfers. Gait with 4WW Mod I over all surfaces 150+ ft. Gait with NBQC SBA for 50 ft with minimal verbal cues. Re-asses appropriateness of AFO prior to D/C.	YES YES YES YES

L=left; UE=upper extremity; FWW=front wheeled walker; ft=feet; W/C=wheelchair; AFO=ankle-foot orthosis; R=right; D/C=discharge. See Appendix A for definitions of assistance level.

Mobility and Ambulation

The patient was proficient in operating a powered wheelchair by week 2. Gait training was initiated in week 3 of his IRU stay and progressed from a total of 130 feet with seated rest breaks and moderate assist of two during the first gait training session to modified independence with 1000+ feet of ambulation and no rest breaks. The patient was able to navigate busy, crowded areas of the hospital as well as enclosed spaces such

as his room and bathroom. Assistive devices progressed throughout the course of treatment from a FWW to a four wheeled walker (4WW) for long distances and a NBQC for shorter distances. Through the duration of the gait training portion of treatment, gait deviations such as increased terminal knee extension and toe drag were noted on the right. Likely due to muscle fatigue, these deviations increased with increased distance. Upon consultation with an orthotist, it was determined that these deficits were not sufficient to warrant the use of an ankle-foot orthosis (AFO).

Table 3. FIM scores at discharge.

Category	Comments	D/C Score
Transfers	Mod I with all bed mobility and functional transfers; pt able to rise from the mat without the use of arms	6
Toilet	Mod I with toileting—uses rails and NBQC to navigate bathroom	6
Ambulation	Primary AD is 4WW, Mod I 1000+ ft; Mod I 50 ft with NBQC; Sup-SBA for greater than 50 ft with NBQC—balance related	6
W/C mobility	N/A—pt no longer using WC for mobility	--
Stairs	Pt able to ascend/descend 10 steps x2 with rail on the right	6
ROM	AROM WFL bilateral UE/LE	
Strength	Per MMT screen at edge of mat: L LE grossly 4+/5, R LE grossly 3+/5; Trendelenberg noted on L during gait indicating R abductor weakness	
Neurological Deficits	Pt occasionally describes "tingling" and altered sensation in bilateral hands; sensation otherwise intact bilateral UE/LE	

Mod I=modified independent; pt=patient; NBQC=narrow base quad cane; AD=assistive device; 4WW=four wheeled walker; sup=supervision; SBA=standby assist; AROM=active range of motion; WFL=within functional limits; UE=upper extremity; LE=lower extremity; MMT=manual muscle test.

Balance

Balance was initially observed and recorded using a subjective scoring scale of poor, fair, or good with plus signs (+) and minus signs (-) to indicate gradations in balance performance between the three scores. Using this subjective poor-fair-good scale for balance observation, the patient progressed from initial ratings of fair in static, sitting positions in week two to ratings of good minus in dynamic, standing postures in week seven. A rating of good minus indicates that there is some remaining safety concern for the patient when performing high level, dynamic functional movements. In this patient's case, residual LE weakness bilaterally necessitated extra time and conscious attention for safety during ambulation and other dynamic activities. Additionally, the patient experienced minor difficulty with advancing the right leg during gait due to dorsiflexor weakness, which presented a safety concern.

As the patient did not ambulate during the first two weeks, no standardized ambulation or balance measure was performed. Starting in week four, the Tinetti Performance Oriented Mobility Assessment (POMA) was implemented for measurement of gait parameters and balance as well as for insight into fall risk. The POMA is a 16-item performance measure which contains two subtests: a 9 item balance test and a 5 item gait test.[13] Items are scored either on a 3-point scale or as can/cannot perform based on the tester's observations for a total score of 28. Validity testing has shown a .91 correlation with the Berg balance test and a .75 correlation with the Barthel index.[13] Fall risk criteria have also been developed: a score of greater than 24/28 indicates a low risk of falls, a score

between 19 and 24 indicates moderate risk of falls, and a score of less than 18 indicates a high risk of falls.[13]

Table 4 describes gait subset, balance subset, and total scores on the POMA over the last half of the patient's inpatient unit stay. Deficits in each subtest at each testing date are listed to show areas of progress. Note that based on the scoring of the test, there is a slight ceiling effect for those using a gait aid; the POMA incorporates an automatic score deduction of 3 points for any patient who uses an assistive device. Therefore, the patient's gait score could not increase above 9 out of 12 total points due to the need for an assistive device. However, it could be reasoned that any underlying pathology which necessitates the use of an assistive device puts the patient at increased risk of falling. Despite this, the patient was able to obtain a score of 24/28 in his last week of inpatient rehabilitation, indicating he successfully moved into the low risk of falls category. Also of note is the fact that the patient's need for external support decreased over the course of his rehabilitation, as evidenced by the progression of assistive devices from more supportive (FWW) to less supportive (NBQC).

Table 4. POMA scores over the course of treatment. Bold value indicates low risk of falls categorization.

Date (Week)	Type of AD	Gait Score (deficits present)	Balance Score (deficits present)	Total Score
4/6/10 (Week 4)	FWW	8/12 (path deviation, uses walking aid, wide BOS)	10/16 (compensation during sit-stand, unsteady immediate standing, wide BOS, unsteady with EC, discontinuous steps, uses arms to sit)	18/28
4/19/10 (Week 5)	4WW	9/12 (uses walking aid)	14/16 (Discontinuous steps, uses arms to sit)	23/28
4/30/10 (Week 7)	NBQC	9/12 (uses walking aid)	15/16 (Discontinuous steps while turning without AD)	**24**/28

AD=assistive device; BOS=base of support; EC=eyes closed; FWW=front wheeled walker; 4WW=four wheeled walker; NBQC=narrow based quad cane.

Other

By discharge from the IRU, the patient was independent in managing a bowel and bladder program.

Discussion

This case reports the functional return experienced by a 67-year-old patient following an infection-related spinal cord injury. Despite having a cervical SEA, which is correlated with poorer motor outcomes[8], the patient demonstrated rapid and meaningful functional gains. He was able to meet and exceed all goals set by his treating physical therapists and return to living in his home with his wife. Homecare PT and nursing services were ordered for this patient as he was scheduled to be on IV antibiotics for an additional 10 days. When his antibiotics were discontinued, a transition to outpatient therapy services was recommended for continued functional gains.

Drevelengas et al[6] reported a similar case of cervical SEA with a soft tissue origin in a 70-year-old male with no identifiable risk factors. Location of the SEA was similar in the two cases and management included surgical and pharmacological treatments. Presenting signs were similar to the current case and included pain, weakness, and sensory deficits. The main difference between these cases, however, is that the patient in the previously reported case had no neurological involvement following surgical intervention. For the current patient, neurological deficits remained, necessitating a seven-week stay in the IRU.

This patient's outcomes support the previously reported recovery potential of individuals with SEA. Soehle et al[8] reports that 60% of patients that are affected by SEA have good

motor outcomes. Additionally, Koo et al[14] report that patients with SEA have greater improvements in motor function when compared with similar patients following TSCI. On the other hand, the patient's meaningful functional gains contrast with reports that those patients with moderate disability,[21] are bedridden prior to surgical intervention, [21] or have prolonged paralysis.[11]

While it is impossible to make causative links between the patient's stay in the IRU and his favorable outcomes, it is reasonable to state that the combined interventions of all of the disciplines involved as well as neural regeneration played key roles. Also, the patient was exceptionally motivated and had a very supportive family. His adherence to the PT plan of care and positive attitude throughout the course of treatment likely influenced his positive outcomes.

One of the limitations of this study is the lack of specific muscle testing grades upon admission and discharge, as is commonly reported in the spinal cord injured population. However, the treating therapists believed that function was an adequate measure to follow this patient. The focus of treatment within the IRU was on allowing enough functional recovery to allow him to return home. Another limitation of this study is the presence of multiple treating therapists. In addition, the primary treating PT and student PT were unable to perform the initial evaluation. Minimizing the crossover between therapists would have allowed for continuity in documentation, a better continuity of care for the patient, and improved reliability of repeated measures. Finally, the student PT

involved in the treatment of this patient was not formally trained in the administration of the FIM. While informal training by members of the rehabilitation team was performed, the inter-rater reliability of measures throughout the patient's stay may have been affected.

Medical and surgical techniques have been well represented in the literature and a gold standard of treatment has been developed. There is currently a lack of agreement in the literature concerning motor outcomes after SEA, with two recent articles reporting greater functional improvement in patients with TSCI than with SEA[15, 16], and one recent article reporting just the opposite[14]. Areas for further research exist in the realm of parameters for rehabilitation as well as quality of life outcomes following SEA. A major limitation of some previously published reports of outcomes after SEA is the lack of standardized measurement of motor outcomes. In several studies[4,6,8,11,21], functional outcome is described with non-standardized scales or minimal information is provided regarding level of functional independence.

According to Behrman et al[22], a paradigm shift has been occurring in neuroscience and rehabilitation over the past 30 years. Due to the discoveries of the plasticity of the nervous system based on animal studies, rehabilitation after TSCI has been shifting away from the use of compensatory strategies toward a greater emphasis on restoration of motor-spared areas. Animal models in the literature have also highlighted the importance of activity-specific and intensive practice in making functional gains. Somers[23]

conducted an extensive review of the literature regarding motor recovery after SCI and concluded that compensatory models are likely still appropriate for some portion of the SCI population, namely those with motor complete lesions. With regard to the physical therapist's approach to a patient with SCI, Somers has identified portions of the total population that would likely benefit from a restoration-based approach (Figure). It is likely that those with a designation of ASIA C or D, regardless of mechanism of injury, would likely benefit from a restoration-based treatment approach, as was utilized in this case report.

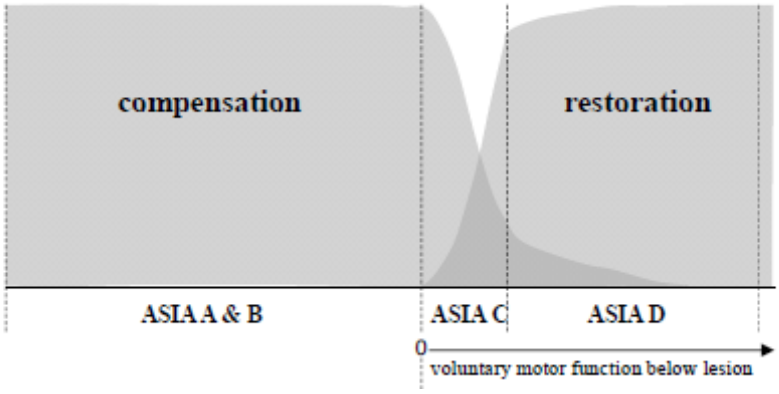

Figure 1. Compensation and restoration in rehabilitation after spinal cord injury.[23]

In light of controversy over possible differences in outcomes for the TSCI and SEA populations, cases of this kind are a key to guiding referral to inpatient rehabilitation units for patients post-SEA in order to maximize functional gains. Due to the rare nature of the diagnosis, randomized control trials are perhaps not the most appropriate method of reporting outcomes for patients post-SEA. Case reports allow for reporting of in-depth diagnosis and treatment of this rare disorder. While this information can be especially

useful in acute and inpatient settings, general knowledge of signs and symptoms of SEA could aid in differential diagnosis in other settings. Increasing direct access in the PT profession obligates PT professionals to be knowledgeable on the presentation of abnormal neurological symptoms and the sequelae of infection.

Summary and Conclusions

This case report supports previously published articles reporting the favorable prognosis for survivors of SEA[6,8,14] but conflicts with other reports of fewer functional gains for patients with SEA[15,16]. The patient presented with indicators of poor prognosis including cervical location of the SEA, decreased lower extremity strength,[8] and neurological symptoms lasting longer than 36 hours[11]**.** Functional gains were seen in the areas of functional mobility and ambulation, balance, and strength following multimodal treatment with surgical decompression, antibiotics, and inpatient rehabilitation. While comment cannot be made on the causative relationship between rehabilitation and the patient's favorable outcomes, it is reasonable to state that they played a crucial role in his ability to return home.

Appendix A. Case Report Information and Consent Form

Introduction:

You are invited to be the subject of a case report to be written by

_____, Doctor of Physical Therapy graduate student/s from St Catherine University, under the supervision of Debra Sellheim, PT, PhD, Doctor of Physical Therapy program faculty member, and _____, the student's clinical instructor/s. You were selected as a possible subject for this case report because your course of physical therapy care would be of interest to physical therapist students and physical therapists. Please read this form and ask questions before you agree to be the subject of this case report.

Background Information:

The purpose of this case report is to describe the physical therapy care you are receiving and how you respond to the care you are receiving at

_____

(name and address of facility).

For example, the case report would describe the following:

1. why you are receiving physical therapy at this time;
2. the kinds of physical therapy treatment/s you are receiving at this time;
3. the effectiveness of the physical therapy treatment for you at this time.

This case report will help others better understand how physical therapy may help other people like you.

Procedures:

Your decision about participation will not affect your physical therapy care in any way. If you decide to participate, your physical therapy care will proceed just as it would if you were to decide not to participate. If you decide to participate, you may choose whether or not you will allow the following:

1. whether your photograph can be taken and used in public presentation and/or publication of this case report;
2. whether what you say can be quoted directly in the case report.

You may be given an opportunity to read or review parts, or all, of the case report prior to its completion, so that you can make suggestions to the student about the accuracy of the information described in the case report. You are not obligated to read/review the case report, however.

The case report will be read by the student's faculty supervisor, Debra Sellheim. This case report may be read by the physical therapist/s supervising the student at this facility. The case report will

be presented publicly by the student/s at St Catherine University Doctor of Physical Therapy Program Research Day. This case report would be available for students and faculty at the St Catherine University to read. The case report may also be published in a scientific journal and/or presented at a professional meeting locally or nationally.

Risks and Benefits:

There are no risks or benefits to you for participating in this case report.

Confidentiality:

Any information obtained in connection with this case report that could identify you will be disclosed only with your permission. Unless stated otherwise, your name, or names of your family members, will not be used in any way in the case report.

Voluntary nature of this case report:

Participation in this case report is voluntary. Your decision whether or not to participate will not affect your future relations with the St Catherine University, or with the facility at which you are receiving physical therapy. If you decide to participate, you are free to discontinue participation at any time without affecting these relationships.

Contacts and questions:

You are encouraged to ask the student or the physical therapist supervising the student any questions about this case report, at any time. You may also contact the student's faculty supervisor, Debra Sellheim, if you have any questions, at any time.

You may keep a copy of this consent form for your records.

See next page for Statement of Consent

Statement of Consent:

You are making a decision whether or not to participate in this case report. Your signature indicates that you have read this information and your questions have been answered. Even after signing this form, please know that you may discontinue your participation in this case report, at any time.

I agree to participate in this case report. Yes ____ No____

I agree to being quoted directly in this case report. Yes____ No____

I agree to being photographed and having the photographs included in the public presentation and/or publication of this case report. Yes ____ No____

If the student wishes to have me read or review the case report prior to its completion, the student may contact me, after my course of physical therapy is complete. If I check no, that means I do not want the student to contact me at any time, after my course of physical therapy is complete.

Yes____ No____

_____

Signature of subject Date

_____

Student's signature Date

Faculty member supervising the student:

Debra Sellheim, PT, PhD
Associate Professor and Curriculum Co-Director
Doctor of Physical Therapy Program
St Catherine University
601 25th Avenue South
Minneapolis, MN 55454
Phone: 651-690-7716

Appendix B. FIM scoring system[14]

Score	**Description**
1—Total assist	Total assistance or not testable—patient performs less than 25%
2—Max assist	Maximal assistance—patient performs 25% of the task or more
3—Mod Assist	Moderate assistance—patient performs 50% of the task or more
4—Min assist	Minimal assistance—patient performs 75% of the task or more
5—Sup	Supervision—patient performs 100% of the task but requires supervision
6—Mod I	Modified Independent—patient performs 100% of the task but uses an assistive device
7—I	Independent—patient performs 100% of the task in a timely, safe manner

Appendix C. Interventions during inpatient rehabilitation

	Treatment category			
Wk	**Endurance**	**Strengthening**	**Mobility/Ambulation**	**Balance**
1	NA	Supine LE ex (manual resistance, isometrics)	Sliding board transfers, stand-pivot	NA
2	Sitting edge of mat; NuStep; prone for positional tolerance	Supine and seated UE/LE ex (manual resistance, weights) rolling; trunk rotation in hook lying; trunk flexion	Power chair training; stand-pivot transfers; bed mobility on various surfaces	Seated reaching
3	Standing; NuStep	Quadruped; bridging; supine/sidelying AROM of LE through full gravity-eliminated range; trunk rotation; seated LE/UE exercise;	Continued use of power chair as primary mode of transport; sit-stand transfers; begin ambulation in therapy	Seated/standing ball toss; Wii Boxing in standing
4	NuStep	Scapular AAROM against gravity; advanced bridging; crunches from wedge pillow; trunk rotation; seated shoulder alternating isometrics	SBA to CGA for ambulation with FWW; HHA for increased challenge; attempted floor transfer	Standing balance with UE activity; side and retro-walking with HHA; step-touch; Wii balance games
5	NuStep	Supine and seated LE exercises with (weights, theraband); crunches from wedge pillow	A ambulation with FWW, 4WW; up/down stairs with one rail; ambulation over uneven terrain with 4WW	Stepping over obstacles; standing balance with UE activity or perturbations; wide and narrow BOS standing, EO/EC; Wii Balance games
6	NuStep; gait up to 1000 ft	Standing ex; crunches from wedge pillow; side stepping; seated punching; quadruped; tall kneeling activities	Trial R AFO during gait; gait with 4WW while moving objects; gait (various surfaces)	Standing balance with UE activity; sitting on physioball; Wii balance games
7	Gait 1000+ feet; treadmill walking-5 min bouts up to 1.5 mi/hr	High knee walking; advanced bridging; crunches from wedge pillow; quadruped rocking, shoulder protraction/retraction; tall kneeling; standing trunk rotation	Floor transfer; retro-walking on treadmill	Narrow BOS with perturbations; weight shifting; Wii balance games

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