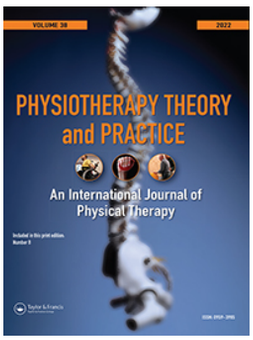

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Physical Therapy Interventions in a Patient with Nontraumatic Incomplete Spinal Cord Injury Secondary to Metastatic Lung Cancer: A Case Report

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ABSTRACT

Background and Introduction: Individuals with dual cancer and spinal cord injury diagnoses present unique challenges to rehabilitation teams. This case report describes the modification of a physical therapy plan of care for an individual with incomplete spinal cord injury (iSCI) resulting from metastatic lung cancer who underwent adjunctive cancer treatment.

Case Description: A 61-year-woman with small cell lung cancer and T5 iSCI presenting to inpatient rehabilitation (IPR) to address function limitations from iSCI following metastatic epidural tumor resection.

Intervention: Interventions focused on task-specific training of mobility skills with modifications made to address cancer-related fatigue, promote energy conservation, and prioritize functional skills for home discharge given anticipated disease progression.

Outcomes: IPR length of stay was 31 days. Functional Independence Measure (FIM) total score increased from 52/133 at admissions to 106/133 at discharge. Spinal Cord Independence Measure – III (SCIM-III) total score increased from 31/100 to 55/100. Functional Assessment of Chronic Illness Therapy-Fatigue Subscale score increased from 21/52 to 41/52 reflecting reduced fatigue level compared to admission. These gains facilitated discharge home with family support.

Conclusion: Physical therapy plan of care required consideration of dual diagnosis, cancer-related fatigue, and patient-centered goals. Participation in IPR positively affected quality of life and ability to return home with family.

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KEYWORDS
Spinal cord injury; cancer; inpatient rehabilitation; physical therapy intervention; fatigue

Background

Lung cancer is the second most common type of cancer with small cell lung cancer (SCLC) accounting for 10–15% of all lung cancers (American Cancer Society, 2018). SCLC is an aggressive form of lung cancer that originates in neuroendocrine-cell precursors with common sites of metastases in the brain and spinal cord. While the initial response rates to chemotherapy and radiation are good for SCLC, resistance to treatment develops rapidly in stage IV with a median progression-free period of only 5.5 months (Früh et al., 2013). The five-year survival rate for those with Stage IV SCLC is around 2%, with a median survival rate of 10 months (American Cancer Society, 2018). Individuals with SCLC with metastases to the brain or spinal cord resulting in neurological injury such as paraplegia present unique challenges for rehabilitation multidisciplinary teams due to the dual diagnoses. Rehabilitation goals must focus on optimizing functional independence, patient-centered personal goals, and enhancing quality of life.

The evidence for the efficacy of inpatient rehabilitation (IPR) in individuals with non-traumatic spinal cord injury (NT-SCI) resulting from metastatic SCLC tumor is very limited. In comparing IPR outcomes, such as discharge Functional Independence Measure (FIM) score, discharge location, length of stay (LOS), and percentage of rehabilitation goals met, no differences were found between spinal cord injury resulting from metastatic cancer and NT-SCI from other causes (Fortin, Voth, Jaglal, and Craven, 2015). Factors such as disease severity, primary tumor location, and age did not affect mobility outcomes in metastatic SCI (Putz et al., 2014). While smaller gains in FIM score were reported in those with metastatic SCI compared to traumatic SCI in two studies, it was also observed that the former had shorter lengths of stay

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in IPR (McKinley, Huang, and Brunsvold, 1999; McKinley, Huang, and Tewksbury, 2000). In observing individuals with NT-SCI, Fattal et al. (2009) reported that a large portion of study participants spent more than a third of their remaining survival time in IPR. Therefore, they recommended that the rehabilitation team should carefully weigh IPR LOS decisions with rehabilitation goals, and try to optimize the patient's time spent at home with family.

There is limited evidence regarding the impact of the potential barriers to participation in IPR for individuals with metastatic SCI. However, the literature regarding these possible barriers during IPR in more general cancer populations may provide insight into these concerns. While transfer rates to acute care hospitals are higher in individuals with cancer diagnoses compared to those without cancer diagnoses; suggestive of a higher rate of medical complications for those with cancer diagnoses, IPR LOS remains similar between the two groups (Guo, Persyn, Palmer, and Bruera, 2008). Previous research reported similar functional gains in FIM and LOS in IPR in individuals with cancer undergoing chemotherapies and radiation treatment compared to those with cancer who did not receive these treatments (Cole, Scialla, and Bednarz, 2000; Marciniak et al., 1996; Tay, Ng, and Lim, 2009). Therefore, despite potentially increased medical complications and the adverse effects of adjunctive cancer treatment, the rehabilitation outcomes in IPR were not detrimentally affected. Regarding the impact of cancer-related symptoms on participation in IPR, one study reported fatigue as an intense symptom during IPR and at discharge (Guo et al., 2007). Cancer-related fatigue may be a significant limitation to participation in intensive therapies during IPR and in daily activities after discharge. Fatigue levels may be adversely affected by the high activity demands of IPR, as well as by medical complications, sleep and nutritional issues, and emotional stress. Therefore, fatigue should be assessed and judiciously addressed in the development of a physical therapy plan of care during IPR.

While there is limited support for the feasibility and efficacy of IPR for individuals with metastatic NT-SCI, there is a paucity of research that specifically investigates the necessary modifications in physical therapy plan of care during IPR and the responsiveness to physical therapy interventions given the dual cancer and metastatic NT-SCI diagnosis. Considerations for cancer-related symptoms such as fatigue and the limited survival rate associated with stage IV cancer must be integrated into the plan of care with the goal of optimizing participation in physical therapy during IPR and independence with functional mobility upon discharge. The purpose of this case report is to describe the modifications of a physical therapy plan of care in IPR and describe rehabilitation outcomes for a patient with an incomplete NT-SCI and metastatic lung cancer undergoing adjunctive cancer treatment.

Case description

Patient History

The patient was a 61-year-old Caucasian woman admitted to an acute care hospital following a standing level fall at home. Prior to the fall she noticed increasing weakness in her legs and was unable to voluntarily urinate. She was a one pack per day smoker and reported 50lbs of unintentional weight loss in the previous few months. Neuroimaging revealed a spinal cord compressing mass at T6. She underwent an emergent T5-7 laminectomy and partial resection of an epidural tumor. Further imaging of the torso and brain revealed a left apical lung nodule, a left suprahilar lymph node, and a residual T6 tumor. After tissue biopsy she was diagnosed with Stage IV metastatic pulmonary small cell carcinoma. Further imaging revealed no bone metastases. Her oncologist recommended radiation treatment and chemotherapy to address residual tumors and metastatic disease. She spent 8 daysin the acute hospital setting and was then transferred to an inpatient rehabilitation (IPR) facility to address functional limitations from NT-SCI.

Refer to Table 1 for the patient's medical history and list of medications. Subjective history revealed that the patient lived in a two-story home with two steps to enter with her terminally ill husband and adult son with unspecified cognitive deficits. She worked full-time and was the sole financial provider for her household. Prior to this cancer diagnosis, she was independent for mobility and all basic and instrumental activities of daily living (ADL) without an assistive device. She reported no functional limitations from her rheumatoid arthritis (RA) diagnosis beyond mild symptoms of joint pain and intermittent fatigue. In the months leading up to her NT-SCI and cancer diagnosis she had several trips to the emergency department for various complaints. During one visit imaging revealed multiple lung nodules. The patient did not seek additional medical evaluation or treatment for these lung nodules due to being uninsured at the time. This case report was approved by the IPR Institutional Review Board and the patient provided her written informed consent to participate.

Table 1. Medical history and medication list.

Medical History	Medication List	
	Scheduled	**PRN**
Rheumatoid Arthritis	Docusare-senna	Acetaminophen
Anxiety Disorder	Enoxaparin (Lovenox)	Acetaminophen – hydrocodone
Hysterectomy	Fluoxetine	Bisacodyl
Lumpectomy-breast (benign)	Multi-vitamin	Calcium carbonate
Appendectomy	Nicotine	Diphenhydramine
	Nystatin topical	Guaifenesin
		Lorazepam
		Naproxen
		Ondansetrom
		Oxycodone
		Simethicone
		Zinc Oxide Topical

Initial clinical examination

A systems review revealed that the patient's passive ROM was within normal limits for all extremities. There was no presence of spasticity based on Modified Ashworth Scale (Tederko et al., 2007). Her vitals were stable, but she became short of breath with mild exertional activities. Integumentary system was unremarkable with exception of well-healing surgical incisions. Motor and sensory testing were completed using AIS testing procedures as described by the American Spinal Injury Association manual (Kirshblum et al., 2011). The AIS has excellent intrarater and interrater reliability in both the acute and chronic SCI populations (Clifton et al., 1996; Curt and Dietz, 1997). The patient had no muscle activation in her legs except for trace activation in a few muscle groups in left lower extremity (Table 2). She demonstrated 0–1/2 scores for light touch sensation below T5, indicating absent or diminished sensation throughout her trunk and lower extremities but had intact sacral sensation. Therefore, initial physical therapy examination findings supported a T5 AIS-C classification SCI.

Her fatigue levels were measured using the Fatigue Subscale of the Functional Assessment of Chronic Illness Therapy – Fatigue Subscale (FACIT-F). This 13-item scale was designed for individuals with cancer to measure the impact of fatigue on daily activities, with lower scores representative of higher levels of fatigue (Butt et al., 2013; Smith, Lai, and Cella, 2010). The FACIT-F has excellent interrater reliability and internal consistency. Fatigue was assessed throughout the patient's IPR admission due to active cancer diagnosis, adjunctive cancer treatment, and history of rheumatoid arthritis to inform the therapist of the need for possible modification to plan of care. Her initial score reflected a moderate impact of fatigue on daily activities and quality of life (Table 2).

The patient's functional mobility skills were assessed using the Functional Independence Measure (FIM) and the Spinal Cord Independence Measure Version III (SCIM- III). While the FIM is the gold standard activity-based measure in inpatient rehabilitation facilities in the United States, it has been found to be less responsive in detecting change compared to the SCIM in the SCI population (Catz et al, 1997). Regardless, the FIM has been found to have excellent interrater reliability in the SCI population and excellent internal consistency for NT-SCI diagnosis (Stineman et al., 1996). The SCIM is an activity-based measure designed for the SCI population with self-care, respiration and sphincter management, and mobility domains, which has excellent interrater reliability for the total score and subscale scores (Itzkovich et al., 2007). Refer to Table 2 for the patient's total and domain scores for the FIM and SCIM-III. Initial function for sitting balance, bed mobility, transfers, and wheelchair mobility are described in Table 3. Standing and ambulation were not attempted due to her level of injury and severely impaired motor function.

Clinical impression (Diagnosis, prognosis, plan of care)

Examination results supported the diagnosis of incomplete paraplegia following resection of a spinal cord tumor resulting in a thoracic level NT-SCI, with the findings consistent with level of SCI and ASIA classification. Based on these findings the physical therapist (PT) determined that the patient was a good candidate for IPR to address functional skill training and equipment needs to optimize her level of independence. The prognosis for neuro-recovery was guarded due to the metastatic SCLC diagnosis, residual spinal tumor, and adjunctive radiation and chemotherapy treatment.

Table 2. Functional outcome measures and impairment scores at admission and discharge.

	Admission	Discharge
AIS Classification	T5 ASIA C	T6 ASIA C
AIS Light Touch Sensory Total Score	Right Side = 32 Left Side = 32	Right Side = 29 Left Side = 35
MAS – Lower Extremities	0 in all major muscle groups	Bilateral Plantar flexors = 3 Bilateral Knee extensors = 3 Bilateral Hip abductors = 2 Remaining Muscle groups = 0
MMT – Lower Extremities	Bilateral MMT scores: Hip flexors = 0/5 Knee extensors = 0/5 Ankle Plantar flexors = 0/5 Ankle dorsiflexors = 0/5 Great toe extensors = 0–1/5 Additional testing due to trace activation at left Great Toe: Left Ankle inversion = 1/5 Left Ankle eversion = 1/5	Bilateral MMT scores: Hip flexors = 1/5 Knee extensors = 2/5 Ankle Plantar flexors = 2/5 Ankle dorsiflexors = 3/5 Great toe extensors = 2/5
SCIM – Version III Total Score	31/100	55/100
SCIM – Self Care	10/20	14/20
SCIM- Respiration & Sphincter Management	18/40	29/40
SCIM – Mobility	3/40	12/40
FIM Total	52/133	106/133
FIM Motor	23/98	71/98
FACIT-F Fatigue Subscale score	21/52	41/52

AIS = American Spinal Injury Association Impairment Scale; SCIM = Spinal Cord Independence Measure; FACIT – F = Functional Assessment of Chronic Illness Therapy – Fatigue Scale; FIM = Functional Independence Measure; MAS = Modified Ashworth Scale; MMT = Manual Muscle Test; NT = not tested

Table 3. Functional outcomes for mobility at initial evaluation and discharge.

	Initial Evaluation	Discharge
Sitting Balance	Able to sit statically with bilateral UE support and minimal assistance but she demonstrated severely limited ability to perform small range weight-shifting and was unable to respond to perturbations in any direction to recover balance requiring maximal assistance for dynamic balance.	Required only close supervision for small range reaching tasks with unilateral UE support sitting edge of bed. She was fully functional and independent for dynamic sitting tasks when supported in her power wheelchair.
Bed mobility	Able to perform supine to short sit at edge of bed with maximal assistance of one person. (FIM = 2)	Able to perform supine to short sit at the edge of a bed with supervision utilizing a bed ladder and leg loop straps. (FIM = 5)
Bed to Wheelchair Transfer	Able to perform a lateral transfer with a slide board from hospital bed to manual wheelchair with moderate assistance of two people. (FIM = 1)	Able to perform a lateral transfer using a slide board from bed to power wheelchair with set-up assist for chair and contact guard assist for the transfer. (FIM = 4)
Toilet & Bathtub Transfer	Required a mechanical lift and assistance of two people to transfer to shower commode chair. (FIM = 1)	Able to perform lateral transfers using a slide board to the drop arm commode and tub transfer bench with the use of a grab bar and contact guard assist. (FIM = 4)
Car Transfer	Unable to attempt due to severity of deficits.	Required maximal assistance to perform a slide board transfer from her power wheelchair to her personal vehicle, an SUV, due to the height of the vehicle seat. (FIM = 2)
Wheelchair Mobility	The patient required moderate assistance to for 30 ft of wheelchair mobility in lightweight manual wheelchair, maneuvering in large open hallway.	Independent in using her power wheelchair in the home and community. Her wheelchair skills included: • Independent pressure relief using forward and lateral lean techniques, • Managing arm and leg rests, and adjusting speed settings • Maneuver the wheelchair in tight spaces, • Drive in reverse, • Perform tight turns, • Ascend/descend inclines • Manage a curb cut

Additionally, it was anticipated that fatigue and exercise tolerance may be barriers to rehabilitation. Appropriate modifications would need to be made to the interdisciplinary plan of care to prioritize maximizing functional independence and quality of life while supporting a home discharge.

The multidisciplinary team estimated the patient's length of stay at f4 weekswith the discharge disposition to home with support of family and home health services. Under the direction of her oncologist, the medical plan of care was chemotherapy and radiation treatment. She was scheduled to receive radiation treatment to the thoracic spine f4 daysa week for t3 weeksstarting the second week of her IPR stay, and chemotherapy for three consecutive days monthly starting the third week of her IPR stay (Figure 1). Initial physical ttherapy-specific goals and planned interventions are reported in Table 4. Given the patient's dual diagnosis of metastatic cancer and planned adjunctive cancer treatment, physical therapy goals did not include a standing or ambulation functional goal despite the expectation that some recovery of motor control might occur. The patient actively participated in goal setting and agreed with these goals, indicating that she would prefer to maximize her independence with functional mobility from a wheelchair level. This would facilitate a shorter length of stay to allow her to capitalize on her time with her family and to reduce the burden of care on her family members. The patient's husband's terminal cancer diagnosis and limited life expectancy factored into the patient's decision-making. She expressed the desire to be as independent with functional mobility as possible to avoid burdening her husband and son, while minimizing her length of stay in order to spend more time with her family.

Intervention

During IPR the patient was scheduled to receive a minimum of 15 hours of combined physical and occupational therapies a week initially delivered in a standard 3 hours a day, 5 days a week schedule. This schedule was adjusted to 15 hours a week of therapies over 7 days when concurrent chemotherapy treatment was initiated on Day 18 of IPR to accommodate for her significant fatigue levels. Physical therapy session attendance was greater than 95% and the patient completed 15 hours of therapy each week except for 1 week, in which she missed 45 minutes due to her medical treatment. Task-specific training of bed mobility, transfers, and wheelchair mobility skills were prioritized by the PT. Refer to Table 5 for details regarding treatment interventions, task modifications, and skill progressions. She was fully engaged in the active learning process and modifying tasks based on her personal resources and constraints from the NT-SCI.

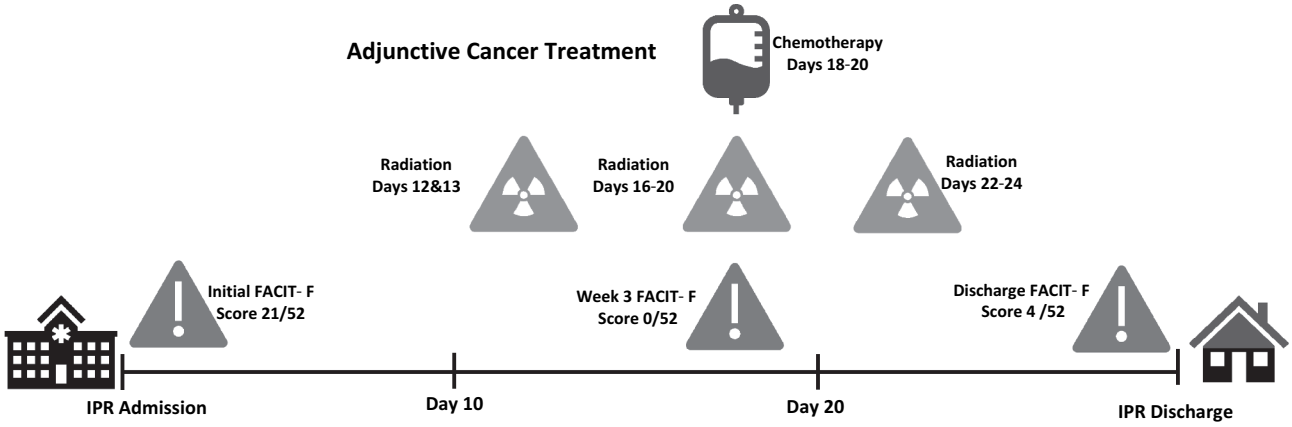

Figure 1. Impact of Adjunctive Cancer Treatment on Fatigue based on the Fatigue Subscale of the Functional Assessment of Chronic Illness Therapy – Fatigue Subscale (FACIT-F) Score. Note: This figure represents the patient's perception of her fatigue levels at three points in time throughout her IPR stay relative to the timing of adjunctive cancer treatments. Lower scores are representative of greater impact of fatigue on daily life.

Based on the patient's level of neurologic SCI and AIS classification, compensatory strategies were utilized for task-specific training. Standard paraplegic compensatory strategies for bed mobility were found to be very taxing for this patient who had limited energy reserves due to the cancer (Somers, 2010). Therefore, adaptive equipment was used to promote energy conservation (Table 5). Lateral transfers with a slide board were performed as this was the safest and most feasible option for the goal of independence at home while considering energy conservation. Task-specific training for wheelchair mobility was modified early in the plan of care from manual wheelchair skills to power wheelchair mobility training following an exacerbation of her Rheumatoid Arthritis during week-one. A power wheelchair would afford her the opportunity for independent mobility in the home and community, even on days when fatigue and illness may otherwise render her dependent on the assistance of another person. Collaboration between a seating PT specialist, the patient and the primary PT led to the decision to prescribe a center wheel-drive, power wheelchair (Compass HD GP620, Golden Compass Technologies, Old Forge, PA) with a specialized combination air-filled and foam seat cushion. She did not require power tilt or power leg elevation functions as she was independent with pressure relief techniques.

Neuromuscular reeducation interventions were not prioritized as highly as functional training during her IPR stay despite the possibility of limited motor recovery due to sparing and neuroplasticity. Neuromuscular reeducation interventions primarily focused on training sitting balance skills and on assisted use of lower extremities for improved independence with functional activities such as transfers and basic ADL (Table 3). She had fluctuating fatigue levels during IPR with severe fatigue (FACIT-F score+ 0/52) reported the week that she began chemotherapy (Figure 1); therefore, functional training was prioritized. Interventions targeting UE strengthening and aerobic endurance were completed 3 days a week during IPR to increase UE strength and endurance for functional mobility and ADL tasks. The patient demonstrated good tolerance to 30 minutes of moderate intensity strength and endurance training. Aerobic and strengthening activities are important components of a physical therapy plan of care both for individuals with SCI and cancer to improve health and quality of life. Patient and spouse education were provided including information about: 1) prevention

Table 4. Physical therapy goals and planned interventions following initial evaluation.

Physical Therapy Goals	Patient will: • Perform bed mobility tasks independently • Perform slide-board transfers to a bed, commode, and tub transfer bench with contact guard to minimal assistance of one person • Perform slide-board transfer to a car with moderate assistance of one person • Independently propel a manual wheelchair in the home and community • Independently perform pressure relief in her manual wheelchair
Planned Physical Therapy Interventions	• Task-specific functional mobility training, sitting balance training, wheelchair mobility and skills training, • Neuromuscular reeducation & facilitation • SCI-specific education regarding considerations for self-care and prevention of secondary and tertiary impairments

Table 5. Physical therapy interventions, treatment modifications, and progressions in plan of care.

Task Trained	Initial Task Demands	Modifications	Progression Concepts
Bed Mobility Training	Compensatory strategies for rolling with use of arm swing for momentum Transition from supine to long sit using upper extremities Initially performed on a wide, firm mat table	Adaptive equipment used to maximize energy conservation. The patient was provided a bed ladder to assist with the transition from supine to sit. Leg loop straps were utilized to assist with the transition from long sit to short sitting.	Weaned physical assistance and verbal cues Progression from mat table→ hospital bed with head of bed elevated 30° → hospital bed with head of bed flat → Queen size bed without railing but with bed ladder. Initially completed without shoes to ease transition from long sit to short sit → completed with shoes, as she would be performing dressing tasks including donning & doffing shoes in bed
Sitting balance	Initially seated edge of mat table with minimal assist from physical therapist, worked on compensatory strategies for sitting without UE support and transitioning UE support between anterior and posterior propping positions.	Sitting balance activities were practiced both at edge of bed and mat, and in wheelchair to optimize functional carryover for daily tasks.	Weaning physical assist as able Progressing to unstable surfaces such as a hospital bed Training limits of stability with unilateral UE support and reaching tasks. Training reactive postural control with small trunk perturbations.
Transfer Training	Compensatory strategies using lateral transfer technique and slide board Initially transfers from hospital bed<>wheelchair and wheelchair<>mat table Initially structured level or slightly downhill transfers Total assistance with wheelchair set-up, slide board placement, and positioning the LEs	Squat pivot and lateral transfers without a slide board were not attempted despite minimal LE motor return due to high energy cost of this task and daily fluctuations in fatigue levels	Blocked skill practice with emphasis on increased efficiency of skill and decreased energy cost. Weaned physical assistance & verbal cues Varied transfer surfaces with task-specific transfer training to drop arm commode, tub transfer bench, recliner chair, and car.
Wheelchair Mobility	Initially began wheelchair mobility training in rigid frame ultra-lightweight wheelchair in open hospital hallways free of obstacles.	For energy conservation purposes and to avoid further rheumatoid arthritis exacerbations transitioned to training power wheelchair mobility skills.	Gradual progression from maneuvering power chair in open hallways to confined and tight spaces, driving in reverse, performing tight turns, and maneuver wheelchair in place for transfers. Gradual introduction of mobility skills around obstacles and in crowded environments, over unlevel surfaces and inclines.
Lower extremity neuromuscular reeducation	Initially passive and active assist ROM with tactile muscle facilitation, while positioned in supine in gravity eliminated positions	No practice of standing and gait activities due to prioritization of interventions and in accordance with patient's goals.	Progression to active assist and active ROM with weaning of facilitation, and progress to partial against gravity motion for target muscles that had partial return. Active assisted LE cycling, then progressing to independent active LE cycling. (MOTOmedViva2 trainer, RECK-Technik GmbH & Co. Betzenweiler, Germany) Attempted upright and supported standing in standing frame (PNG50024 Glider, Easy Stand, Morton Minnesota) with patient demonstrating poor tolerance and significant orthostasis.

(*Continued*)

Table 5. (Continued).

Upper extremity therapeutic exercise	Initially using light weight on cable cross and rickshaw performed seated in wheelchair.	Alternating training days with LE neuromuscular reeducation interventions during PTA sessions to limit frequency & volume of upper extremity exercise and avoid excessive upper extremity fatigue.	Increasing resistance and number of repetitions – 2 sets of 15 repetitions.
	Beginning with 1–2 sets of 10 repetitions with < 20 lbs. of resistance.		Progression to free weights – progressing from 2lbs to 3lb weights.
		On days that fatigue was severe LE therapeutic exercises performed in supine were better tolerated than UE exercises seated in wheelchair.	UE ergometer (gear 1) to address neuromuscular and cardiovascular endurance.

LE = Lower extremity, UE = Upper extremity, ADL = Activities of Daily Living

and management of secondary impairments related to SCI; and 2) management of cancer-related fatigue and teaching energy conservations techniques. Dedicated time was spent on education regarding pressure relief and avoiding sheering forces with bed mobility and transfer tasks, as the patient had developed a small stage II sacral pressure ulcer early during her IPR stay.

Outcomes

Discharge evaluation of the impairment and functional outcome measures are reported in Table 4. Limited neurologic recovery was evident during IPR with improved MMT strength scores ranging from 1 to 3/5 distributed in the lower extremity muscles and fully intact light touch and pin prick sensation through the T6 distribution. This neurologic exam reflected a change in AIS classification to T6 AIS C. Her spasticity significantly increased with MAS scores of 3 in the knee extensors and ankle plantar flexors bilaterally. At discharge from IPR she demonstrated significant gains in her functional mobility skills reflected by marked improvements in FIM scores (40.6% improvement) and SCIM-III mobility scores (22.5% improvement) (Table 2). Functional outcomes for sitting balance, bed mobility, transfers, and wheelchair use are reported in Table 3. These functional gains allowed her to participate more fully in her ADLs and reduced the burden of care on her family, which supported her home discharge. At discharge she scored a 41/50 on the FACIT-F, indicating minimal impact of fatigue on daily activities. However, fatigue levels were expected to vary with ongoing radiation and chemotherapy treatment, as well as with cancer progression.

At discharge, she had met all functional mobility goals with the exception of: 1) independence in wheelchair mobility with use of manual wheelchair (achieved with power wheelchair); and 2) performing car transfers with a slide board and moderate assistance of one person. After 31 days in IPR the patient was discharged home with intermittent assistance required from her husband and son. Home health nursing, occupational therapy, and physical therapy services were recommended to assist her with improving independence with self-care, ADL, and functional mobility tasks in the home setting. Upon completing these home health goals, the PT also recommended that the patient transition to outpatient physical therapy for greater focus on LE neuromuscular reeducation activities and progressing to supported standing activities if this aligned with the patient's personal goals.

Discussion

This case report describes modifications to an IPR physical therapy plan of care and treatment outcomes for an individual with dual diagnoses of incomplete NT-SCI and stage IV lung cancer. The patient had meaningful gains in her functional mobility skills during IPR, which supported her discharge home. Despite the diagnosis of metastatic cancer, she achieved functional outcomes consistent with the anticipated outcomes for individuals with traumatic incomplete SCI (iSCI) at similar neurologic classification. The reported average FIM-Motor score for individuals with traumatic T1-9 iSCI with AIS C classification is 76 at discharge from IPR (Consortium for Spinal Cord Medicine, 2000). The patient's FIM-Motor discharge score was 71. This functional outcome, along with a comparable LOS, is in agreement with previous studies suggesting that LOS, discharge location, and FIM scores did not differ between individuals with iSCI from a metastatic tumor and those with NT-iSCI from other causes (Fortin, Voth, Jaglal, and Craven, 2015). Despite comparable outcomes, there were several differences from standard of care for physical therapy for iSCI to note. The typical wheelchair prescription for an individual with iSCI at the T5-6 level would be an ultra-lightweight manual wheelchair, whereas the patient was prescribed a power wheelchair. At the time of IPR discharge an individual with T5-6 iSCI may be able to perform lateral transfers and bed mobility tasks without the use of adaptive equipment. In contrast, the patient required use of adaptive equipment for these functional mobility skills to minimize her fatigue with daily tasks while still achieving independence. Additionally, there is typically greater focus on neuromuscular reeducation during intensive IPR for individuals with iSCI with more time allocated to supported standing, functional electric stimulation and gait training interventions in the physical therapy plan of care (Fehlings et al., 2017; Wessels, Lucas, Eriks, and De Groot, 2010). Given her dual diagnosis of metastatic cancer, ongoing adjunctive cancer treatment, and poor medical prognosis, modifications to the patient's physical therapy plan of care and shifts in treatment priorities were necessary.

The patient experienced cancer-related fatigue and nausea, which affected her full participation in physical therapy on a few days, but she did not refuse any therapy sessions due to these symptoms. She was medically stable throughout her IPR stay and did not experience any medical complications or acute care transfers. She was highly intrinsically motivated and worked through her symptoms. An adjusted therapy delivery schedule, along with modifications to therapy interventions as described earlier facilitated her to continue active participation in intensive therapies. Her consistent engagement in rehabilitation despite side effects from chemotherapy and the lack of medical complications are positive factors that contributed to her good functional outcomes.

Cancer-related fatigue was an important symptom that the interdisciplinary team monitored and considered in the plan of care decisions for the patient. This issue specifically affected many physical therapy intervention decisions. The PT prioritized energy conservation during therapy activities and appropriate dosing of interventions, while carefully monitoring her daily fatigue levels. Prescribed interventions involved light to moderate intensity of activity with increased rest breaks necessary. The therapist monitored the patient's exertional fatigue during functional skill training activities. The patient's vitals were consistently stable during exercise and her heart rate recovered quickly after a rest break. Modifications such as the use of adaptive equipment for bed mobility training and transfers promoted energy conservation and reserved the patient's energy for a full day of rehabilitation therapies. Concern regarding her fluctuating fatigue levels, progressive cancer stage, and ongoing chemotherapy also influenced the PT's decision regarding wheelchair prescription. Since wheelchair mobility was her primary form of mobility, she needed to be independent in maneuvering in her environment despite cancer-related fatigue or disease progression.

Neuromuscular recovery interventions were intentionally given less priority in the patient's plan of care during IPR. Despite this decision and guarded prognosis, she demonstrated lower extremity motor return during IPR (Table 4). Her self-reported priority goals were to be as independent with basic mobility tasks at wheelchair level as possible and to maximize the amount of time she could spend at home with her family. She discussed openly with the physical therapist about her cancer prognosis and what therapy goals were important to her. Neuromuscular training interventions that were utilized with the patient did not include standing and gait activities, as these activities required high energy expenditure given her AIS level and would have limited her time engaged in other task-specific functional training. At discharge she was issued a therapeutic exercise program to improve motor function, which consisted of AROM and isometric exercises for the lower extremities. It was anticipated that she would transition from home-based to outpatient physical therapy where a greater priority may be directed to neuromuscular training and ambulation if these activities were consistent with the

patient's goals. Optimal timing for the recovery of motor control and neuroplasticity is not well understood in iSCI but with targeted physical therapy interventions improvements in motor recovery and functional independence have been reported greater than 2 years post-onset of injury (Consortium for Spinal Cord Medicine, 2000; Fouad and Tetzlaff, 2012; Lynskey, Belanger, and Jung, 2008) This finding supports the feasibility that the patient may have continued gains in motor return and functional mobility during outpatient physical therapy should she chose to continue with rehabilitation.

Conclusion

This case report describes the modifications made to a physical therapy plan of care during IPR for an individual with NT-iSCI and stage IV lung cancer, who was undergoing adjunctive cancer treatment. Despite her advanced cancer stage and metastasis resulting in NT-SCI, the patient achieved functional outcomes comparable to those anticipated for individuals with T5-6 AIS-C iSCI. Modifications to physical therapy goals and interventions were necessary to address this patient's cancer-related fatigue and anticipated disease progression. Prioritization of patient-specific goals, her quality of life, and a home discharge guided clinical decisions in this case. Given the nature of a case report, findings from this report can't be generalized to other patients with NT-SCI from metastatic cancer and especially to those with higher medical acuity or cancer-related complications while undergoing inpatient rehabilitation. This case report, however, may inform clinicians about factors that could be considered in a physical therapy plan of care and possible modifications to interventions during IPR in patients with metastatic NT-iSCI. Future research should investigate the IPR team decisions and the complex factors that affect case management decisions and functional outcomes in individuals with metastatic NT-iSCI.

Disclosure statement

The authors have no conflicts of interest to declare.

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