12-4-2015

Use Of Therapeutic Exercise, Functional Endurance, And Gait Re-training In A Deconditioned Patient With Acute Respiratory Failure: A Case Report

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The patient signed an informed consent allowing the use of medical information and video footage for this report and received information on the institution's policies regarding the Health Insurance Portability and Accountability Act

The author acknowledges Amy Litterini, PT, DPT, for assistance with case report conceptualization, Greta Fredriksen, PT, MS, for supervision and assistance with photo footage and the patient for participation in the case report.

ABSTRACT

Background and Purpose: The human body requires oxygen-rich blood to work efficiently. Respiratory failure occurs due to a lack of oxygen passing from the lungs into the bloodstream or if the lungs cannot remove carbon dioxide from the blood. The purpose of this case report was to describe the therapeutic exercise, functional endurance and gait training for an individual following acute respiratory failure (ARF) and (1) document the practicability of this therapeutic approach in an intensive inpatient rehabilitation setting, (2) record the outcomes that occurred for the patient, and (3) discuss the possibility for further research regarding a similar physical therapy (PT) approach for patients with ARF.

Case Description: The patient was a middle-aged female, wheelchair bound due to rheumatoid arthritis in both knees upon admission into the rehabilitation medicine unit (RMU) due to ARF. She received PT for 30-150 minutes each day, 5-7 times per week, for 24 days focusing on therapeutic exercise, functional endurance, and gait training. Outcome measures included: manual muscle testing (MMT) to assess lower extremity (LE) strength; observational gait analysis; functional balance grades; timed standing tolerance; and Functional Independence Measure (FIM) to assess level of independence for transfers, stairs and locomotion.

Outcomes: When comparing outcome measures from admission to discharge, the patient demonstrated a general improvement in bilateral LE strength, functional balance grades, timed standing tolerance, and FIM scores. She significantly improved gait function, exceeding her baseline distance before admission.

Discussion: This case report documented the improved functional outcome measures following therapeutic exercise, functional endurance and gait training for a patient following ARF in the RMU. Future research is warranted to make any causal inferences on this therapeutic approach.

Manuscript Word Count: 3,429

Background and Purpose

According to the National Institutes of Health, the human body requires oxygen-rich blood in order to work efficiently.[1] During respiration, air passes from the nose and mouth and into the alveoli of the lungs. When air reaches the alveoli, oxygen passes into the capillaries, while carbon dioxide moves out of the capillaries, otherwise known as gas exchange. Respiratory failure may occur when there is a lack of oxygen passing from the lungs into the blood (hypoxemic), or if the lungs cannot remove carbon dioxide from the blood (hypercapnic). It is possible to have a low oxygen level and a high carbon dioxide level in the blood simultaneously.

Respiratory failure can be acute or chronic. Chronic respiratory failure may be caused by conditions that affect the nerves and muscles involved in respiration, such as muscular dystrophy, amyotrophic lateral sclerosis (ALS), spinal cord injuries, or stroke. Acute respiratory failure (ARF) is a sudden and serious complication. It can occur in the hospital as a result of various conditions such as pneumonia, adult respiratory distress syndrome (ARDS), and congestive heart failure (CHF).[1,2]

Initially, patients with ARF are typically treated with supplemental oxygen while the underlying cause is identified. In severe cases, patients may require invasive mechanical ventilation (IMV) or noninvasive ventilation (NIV). ARF is the most frequent reason for admission to the intensive care unit (ICU), and has a mortality rate of 33-37% for patients who require IMV.[2]

Although some research discusses the importance of early mobilization in the ICU after ARF,[3] limited research exists on the impact of physical therapy (PT) and gait training (GT) in the rehabilitation medicine unit (RMU) following ARF. This case was unique because the patient had a variety of chronic and acute medical issues, including ARF, factoring into her admission diagnosis and this case report could help to fill a gap in the literature. The purpose of this case report was to

document the outcomes of therapeutic exercise, functional endurance, and gait re-training in a deconditioned patient, following ARF.

Case Description: Patient History and Systems Review

The patient signed an informed consent allowing the use of medical information and photo/video footage for this report and received information on the institution's policies regarding the Health Insurance Portability and Accountability Act. The patient was a middle-aged woman, wheelchair bound secondary to rheumatoid arthritis; she reported having bilateral knee flexion contractures for several years. She lived in a two-story, wheelchair accessible home. She was previously independent with her power wheelchair at home and within the community, and needed minimal assistance from her husband with self-care activities. She independently used forearm crutches to ambulate approximately fifteen feet from her bedroom to her bathroom, and to access restrooms in the community when away from home. The patient owned an accessible van in which she drove to work. She worked full-time for the state, where she performed duties from her power wheelchair.

Additional medical history included morbid obesity and sleep apnea, necessitating a Continuous Positive Airway Pressure (CPAP) machine initiated a few years prior to admission. She also had hypothyroidism, dyslipidemia, osteoarthritis, rheumatoid arthritis, chronic left hip pain, left knee arthroscopy, cholecystectomy, colostomy, bowel resection, diverticulitis, cesarean section, hysterectomy, iron deficiency anemia, and depression. She was taking a variety of medications due to her past medical history (see Appendix 1).

The patient arrived to the Emergency Department with LE swelling, and a thrombus in her left femoral and popliteal area. She was taken to the operating room for a thrombectomy with thrombolysis with tissue plasminogen activator (tPA) and angioplasty to the ileofemoral location.

At that time, an endo-tracheal tube was placed due to ARF. Pulmonary consultation hypothesized that hypercapnic ARF arose due to obstructive sleep apnea and post-operative anesthesia with CHF. After diagnosis, she was treated with bi-level positive airway pressure (BiPAP) with aggressive diuresis. A cardiology consultation showed positive troponin with decreased left ventricular systolic function. She underwent cardiac catheterization five days after her thrombectomy and prior to catheterization an echocardiogram showed an ejection fraction of 20-25%, previously 60%. A normal ejection fraction is typically between 55-70%.[4] The catheterization showed no significant coronary disease. She was treated for fluid overload and her symptoms began to improve.

Due to the ongoing and sudden medical issues along with significant functional decline, the patient required maximal assistance with transfers and self-care, and she was non-ambulatory since admission. Consequently, the acute care team members agreed she would benefit from an inpatient rehabilitation stay to increase strength and activity tolerance, improve functional endurance, and for GT in order to perform her previous level of activities of daily living (ADL) and to return to work.

The patient expressed PT goals to include walking again, specifically from her bedroom to her bathroom using her forearm crutches. She wanted to return to work at some point. A complete systems review was performed, which included the cardiopulmonary, musculoskeletal, integumentary, and neuromuscular systems. Detailed information from the systems review is summarized in Appendix 2.

Clinical Impression #1

Based on the patient's diagnosis of ARF and findings from the systems review, the patient was likely to present with impairments of poor postural control and balance, LE weakness, decreased range of motion (ROM) and aerobic capacity/endurance. These impairments may have contributed to activity limitations of transferring independently, the ability to ambulate and stand

independently, and manage self-care without total dependence. Additionally, participation restrictions including the inability to return to work or drive in the community may have been affected. Environmental factors included her means of transportation, reliance on the power wheelchair and her husband's assistance with some self-care activities. Personal factors included the woman's age, her prior level of function and general health habits, as well as her motivation to participate in PT.

Differential diagnoses may have contributed to the additional factors involved in the patient's medical history. Her left hip pain may have been due to arthritis or sciatica. Decreased activity tolerance and endurance may have been due to disuse and/or fatigue involved with iron-deficiency anemia. The patient was a good candidate for this case report because she had a variety of chronic and acute medical issues factoring into her admission diagnosis, and limited literature can be found on PT interventions in the RMU following ARF.

Examination: Tests and Measures

A complete examination was conducted in the RMU. Functional Independence Measure (FIM), ROM, strength, balance, and coordination were assessed. Since the patient was bedridden at the time of evaluation, gait analysis, distance and endurance could not be assessed. ROM was assessed through active and passive movements of bilateral LEs. Strength was assessed using manual muscle testing (MMT), as described by the Rehabilitation Measure Database as a standardized assessment to measure muscle strength.[5]

To assess balance, functional balance grades were used as described by O'Sullivan and Schmitz in *Physical Rehabilitation.*[6] The FIM was used during examination to measure the level of the patient's disability while demonstrating how much assistance was needed for ADLs as described by the Rehabilitation Measures Database.[7] Timed standing tolerance was planned to

assess aerobic capacity/endurance, however, the patient was unable to complete this portion of the examination. Information regarding the patient's initial examination results are outlined in Table 1, along with the psychometric properties of each outcome measure used.[5,6,7,8]

Clinical Impression #2

The examination data confirmed the initial impression of poor postural control and balance, LE weakness, decreased ROM and aerobic capacity/endurance. It was established that the patient had activity limitations of transferring independently, the inability to ambulate and stand independently, and to manage self-care without total dependence, as well as the inability to drive to work.

The plan was to proceed with PT interventions including therapeutic exercise, transfers, bed mobility, functional endurance, and GT. Since the patient was non-ambulatory and dependent on a mechanical lift for transfers, the plan was to start with attainable goals such as transfers and bed mobility initially, and then move to pre-gait activities. The patient continued to be appropriate for this case report because the impact of PT for a patient with ARF with an inability to ambulate at his/her initial evaluation is not well documented in literature.

The patient was unable to return to work due to mobility and ADL limitations resulting from musculoskeletal, cardiovascular and pulmonary impairments consistent with ARF. Her presentation was as expected, given her previous level of function and chronic musculoskeletal conditions. Her abundance of family support contributed to her motivation and ability to participate in therapy. She was at a high risk for falls, further LE ROM restrictions, and cardiovascular and muscular deconditioning.

The patient's chronic left hip pain, rheumatoid arthritis, long-standing knee flexion contractures and LE deep vein thrombosis may have contributed to her inability to ambulate pain-

free and with efficient gait mechanics. Other co-morbidities that may have negatively affected her prognosis, anticipated goals, expected outcomes and plan of care may have been her recent CHF, iron-deficiency anemia, obesity and depression, contributing to fatigue and decreased activity tolerance. Additionally, her previous reliance on a power wheelchair may have created a plateau for the rehabilitation gains she would demonstrate.

Diagnosis

The patient's ICD-9 primary diagnosis was acute respiratory failure: 518.81. Additional secondary diagnoses included muscle weakness (generalized): 728.87, rheumatoid arthritis: 714.0, and contracture of joint: 718.4.[9]

Prognosis

The patient would benefit from intensive inpatient PT to help improve her functional abilities, reduce her risk of falls, and reduce the amount of assistance she would require for future care, as well as to get back to her baseline of ambulation and mobility. Given the sudden onset of ARF and her previous level of function, the patient had good potential to make functional gains and prevent onset of secondary complications. Nonetheless, she was unlikely to be independent at home by discharge, as she needed assistance prior to admission. She would most likely require physical assistance for some ADLs and aspects of community mobility. Her progress had the potential to be tempered by her motivation to participate in therapy, clinical depression, and the impact of functional decline upon admission into the RMU. Although there is limited research on the impact of PT during the inpatient rehabilitation phase for patients with ARF, it has been suggested by Morris et al.[3] that early mobilization during an ICU admission may predict improved outcomes in ARF.

Plan of Care

The patient was engaged in a four-week inpatient rehabilitation program, and would receive at least three hours of occupational and physical therapy combined daily, five days per week. PT would range from 90-120 minutes per day, split into 30 minute or one-hour sessions. The plan for intervention was to consider the patient's goals while working on bed mobility, transfers, GT, functional endurance, strengthening, stretching, equipment use, and discharge planning. The follow-up evaluation outcomes were gait distance and analysis, functional endurance, FIM, MMT, and balance assessment. Additionally, patient and family education would be provided throughout PT in order for a smooth transition to home and continued rehabilitation progress.

The plan of care (POC) would be organized in a steady, progressive way. Team meetings with short-term goal updates occurred weekly. Length of stay and discharge were set to three weeks at the initial evaluation, and the patient ended up staying four weeks. The POC intention was to meet the patient's goals and help her to return to her physical baseline before her hospital admission, while assisting with increasing her strength and functional endurance. She would also be provided with a home exercise program to maintain her progress and prevent future functional decline. Short and long term goals can be found in Appendix 3.

Interventions

Coordination of the patient's care consisted of a weekly team meeting where all healthcare professionals involved discussed the patient's goals and plan for discharge. Additionally, the patient received therapy on the weekends and her primary PT completed a "coverage sheet update" to provide documentation on what the patient worked on along with her progress made and limitations that remained to subsequent therapists who worked with her each weekend. This allowed for continuity and smooth communication across healthcare providers to deliver the best care possible for the patient.

Continual communication was relayed between healthcare professionals. The referring physician provided a "History and Physical" in her documents, as well as therapy and nursing documentation from her stay in the acute care setting prior to admission. During her stay in the RMU, nursing, OT, PT, nutrition, and social work provided verbal relevant information of her daily progress to team members. Furthermore, each treatment session was documented using an electronic medical system, and any changes in the POC were noted and explained at the time of change.

Patient/client related instruction included a home exercise program, which incorporated written and pictorial demonstration of various LE strengthening exercises. Additionally, discussion of the patient's impairments, activity limitations, and participation restrictions was provided. The POC was discussed with the patient to address her goals as her mobility and transfer ability progressed. Due to the patient's initial apprehension to standing and walking, psychosocial influences on treatment were provided to assist in avoiding a fear of falling. Instruction on equipment use, proper body mechanics, environmental awareness and home safety recommendations to prepare for discharge were included.[10]

The patient received PT for 30-150 minutes per day (split into one-three treatment sessions). The shortest treatment session lasted approximately 30 minutes, while the longest was 60 minutes. This patient received therapy 5-7 days per week for 24 days. By the end of her episode of care she had received an estimated 49 PT treatment sessions.

The procedural interventions used for PT treatment aimed to restore the patient's functional endurance, strength, activity tolerance, and balance. Interventions were also aimed at decreasing reliance on additional equipment and assistance from the patient's therapy team in order to be safely discharged home. The interventions were targeted to improve functional mobility in a timely matter, while also giving the patient time to mentally and physically adjust to the re-training of

many formerly independent tasks. Therapeutic exercise was a key component to the interventions during this patient's treatment plan. According to Kisner et al.,[11] *therapeutic exercise* is the organized and deliberate performance of bodily movement, and activities intended to "remediate or prevent impairments; improve, restore, or enhance physical function; prevent or reduce health-related risk factors; optimize overall health status, fitness, or sense of well-being." These exercise programs were individualized to the specific patient and the beneficial effects of this type of exercise are well documented for not only outpatient PT but also inpatient and post-operative patients.[11]

Additionally, according to Buchner et al.[12] strength and endurance training may have beneficial effects on fall rates and healthcare use in older adults. Preparing the patient for discharge and assisting to prevent fall risk was an important aspect to her care. Her healthcare team needed to be confident that she could be discharged without safety risks, so the strength and endurance training was vital to assist with these goals. Although the patient had been discharged from the ICU and admitted to the RMU during the case report period, an article according to Ronnebaum et al.[13] implies that early mobilization for someone with respiratory distress improves mobility outcomes and decreases length of stay in the ICU; therefore, continued mobilization in the RMU may have further improved these outcomes. See Figure 1 for a detailed list of interventions performed and their rationale.

Interventions were constantly being altered and changed over time. Initially, the patient required a mechanical lift to transfer into and out of bed. Eventually, this lift was discharged from her therapy plan because she regained enough strength and endurance to transfer into and out of bed with maximal assistance from her therapist. Then, the level of assistance for her transfers changed from maximal, to moderate, to minimal, to contact guard assistance, and then to supervision in

some areas. Additionally, gait was not a significant intervention during the beginning of her treatment plan because she could not ambulate and required a power wheelchair, similar to the Sunfire Plus EC,[*] for distance mobility. As therapeutic exercise assisted her functional endurance, she was able to walk in the parallel bars and then with her forearm crutches, similar to Medline Forearm Crutches[†] (see Figure 2 for images of the patient's wheelchair and assistive device), transitioning from high levels of assistance to lower levels, and increasing her gait distances before taking seated rests, as displayed in Figure 3. The patient's balance started to improve and she was soon able to perform therapeutic exercise activities while seated at the edge of a therapy mat without upper extremity support. When certain issues arose, such as left piriformis muscle pain, stretches to decrease her symptoms were added to the interventions. As the patient was able to provide the therapy team with more information regarding her home structure, the POC was altered to accommodate and simulate her home environment. Overall, these changes were required to provide the best quality of care possible with a focus on assisting the patient to meet her goals. See Table 2 for a detailed list of interventions performed each week.

Outcomes

By discharge, the patient met four out of five of her short-term goals, and four out of seven of her long-term goals, detailed in Appendix 3. When comparing outcome measures from admission to discharge, the patient demonstrated a general improvement in MMT of bilateral LE strength. The patient significantly improved gait function, exceeding her baseline distance before admission. At admission into the RMU the patient was non-ambulatory, at discharge she was able to ambulate 18 feet supervised with the use of her forearm crutches. She exceeded her baseline ambulatory distance, as she had been walking a distance of about 15 feet at home before needing to

[*]Drive Medical – 99 Seaview Boulevard, Port Washington NY 11050
[†] Medline Industries, Inc. – 1 Medline Place, Mundelein, Illinois 60060

rest. See Figure 4 for a chart of ambulation progression and level of assistance. Overall, functional balance grades improved, as well as FIMs. See Appendix 4 for a list of FIM scoring.[7] Additionally, improvements were demonstrated in timed standing tolerance when comparing admission scores to discharge scores. She was unable to stand during the initial evaluation, and by discharge she was able to stand for 100 seconds with use of forearm crutches before needing to rest. Table 1 provides a detailed list of outcome measures at discharge.

She was able to complete most transfers with modified independence and mobility with supervision and use of her forearm crutches. The importance of continued assistance from her husband during transfers into and out of bed was discussed prior to discharge, as well as the use of home equipment and her power wheelchair for long distance mobility. Although the patient made significant functional improvements, she continued to experience fatigue following physical activity. Her knee flexion contractures limited her progress in ambulation due to pain and general increased energy expenditure. Overall, the patient was content with her progress and she planned to continue her exercises at home to improve her functional endurance and independence.

Discussion

The patient made good progress during her inpatient rehabilitation stay. Despite her diagnosis of ARF and prior admission to the ICU, she improved her functional mobility from non-ambulatory to exceeding her baseline gait distance. It appears therapeutic exercise, functional endurance and GT along with an interdisciplinary approach to treatment may have assisted in the patient's progress. This case was unique because the patient had a variety of chronic and acute medical issues factoring into her admission diagnosis. Simultaneously, the patient's long-standing rheumatoid arthritis continued to pose range of motion restrictions in her bilateral LEs. The nature of the disease is characterized by chronic inflammation in the joints that can lead to cartilage and

bone damage, disability, and systemic complications.[14] The presence of this autoimmune disorder made it unclear as to whether continued PT in the RMU would improve her symptoms.

This case demonstrated its intended purpose to (1) document the practicability of this therapeutic approach in an intensive inpatient rehabilitation setting, (2) record the outcomes that occurred for the patient, (3) discuss the possibility for further research regarding a similar PT approach for patients with ARF.

Overall there is little information in the literature regarding ARF and PT in the RMU. ARF is the most frequent reason for admission to the ICU, and has a mortality rate of 33-37% for patients who require IMV.[2] Many people who are admitted into the ICU go on to be admitted into the RMU. Therefore, future research is needed to definitively conclude that therapeutic exercise, functional endurance and GT is a practical method of therapy for a patient following ARF in the RMU. Additionally, further research is warranted to examine the effects of therapeutic exercise, including ROM exercises, to reduce chronic knee flexion contractures due to rheumatoid arthritis.

References

1. MedlinePlus Staff. Respiratory Failure. *National Institutes of Health*. https://www.nlm.nih.gov/medlineplus/respiratoryfailure.html. Published August 26 2015. Accessed September 20, 2015.

2. Stefan, M et al. Epidemiology and Outcomes of Acute Respiratory Failure in the United States, 2001 – 2009: A National Survey. *J Hosp Med.* 2013 February: 8(2): 76-82. Accessed September 28, 2015.

3. Morris, Peter. Receiving Early Mobility During an ICU Admission Is A Predictor of Improved Outcomes in Acute Respiratory Failure. *Am J Med Sci.* 2011 May: 341(5): 373-377. Accessed July 14, 2015.

4. American Heart Association. Ejection Fraction Heart Failure Measurement. *Heart.org.* http://www.heart.org/HEARTORG/Conditions/HeartFailure/SymptomsDiagnosisofHeartFailure/Ejection-Fraction-Heart-Failure-Measurement_UCM_306339_Article.jsp#.VmDiLkJqvzI. Published 2015. Accessed December 3, 2015.

5. Rehabilitation Institute of Chicago, Center for Rehabilitation Outcomes Research, Northwestern University Feinberg School of Medicine Department of Medical Social Sciences Informatics Group. Manual Muscle Test. *Rehabilitation Measures Database.* http://www.rehabmeasures.org/Lists/RehabMeasures/DispForm.aspx?ID=1033. Published 2010. Accessed June 30, 2015.

6. Schmidtz, T., O'Sullivan, S. Chapter 6: Examination of Coordination and Balance. In: O'Sullivan, S.B., Schmitz, T.J., Fulk, G.D. *Physical Rehabilitation.* Philadelphia: F.A. Davis Company. 2014. 233.

7. Rehabilitation Institute of Chicago, Center for Rehabilitation Outcomes Research, Northwestern University Feinberg School of Medicine Department of Medical Social Sciences Informatics Group. Functional Independence Measure. *Rehabilitation Measures Database.* http://www.rehabmeasures.org/Lists/RehabMeasures/PrintView.aspx?ID=889. Published 2010. Accessed June 30, 2015.

8. Burnfield, J., Norkin, C. Chapter 7: Examination of Gait. In: O'Sullivan, S.B., Schmitz, T.J., Fulk, G.D. *Physical Rehabilitation.* Philadelphia: F.A. Davis Company. 2014. 252-253.

9. Centers for Medicare and Medicaid Services Staff. ICD-9 Code Lookup. *Centers for Medicare and Medicaid Services.* https://www.cms.gov/medicare-coverage-database/staticpages/icd-9-code-lookup.aspx. Accessed September 29, 2015.

10. Intervention Categories – Guide to Physical Therapist Practice 3.0. American Physical Therapy Association Web Site. http://guidetoptpractice.apta.org/content/current. Accessed July 26, 2015.

11. Kisner C, Colby L. Foundational Concepts. In: *Therapeutic Exercise: Foundations and Techniques, 6th Edition.* Philadelphia: F.A. Davis Company; 2012: 2.

12. Buchner, David et al. The Effect of Strength and Endurance Training on Gait, Balance, Fall Risk, and Health Services Use in Community-Living Older Adults. *The Journals of Gerontology: Series A.* 1996 December: 52(A): 218-224. Accessed July 28, 2015.

13. Ronnebaum, J et al. Earlier Mobilization Decreases the Length of Stay in the Intensive Care Unit. *Acute Care Physical Therapy.* 2012 Summer; 3(2) 204-10. Accessed July 28, 2015.

14. Picermo V et al. One year in review: the pathogenesis of rheumatoid arthritis. *Clin Exp Rheumatol.* 2015 Jul-Aug;33(4):551-8. Available at: http://www-ncbi-nlm-nih-gov.une.idm.oclc.org/pubmed/26203933. Accessed October 19, 2015.

Tables, Figures and Appendices

376 Table 1. Outcome Measures at Admission and Discharge

Tests & Measures	Initial Evaluation Results		Discharge Evaluation Results		Psychometric Properties
Manual Muscle Testing	Left	Right	Left	Right	Test-retest reliability was discussed as excellent for patients with Osteoarthritis, and inter/intrarater reliability is stated as adequate to excellent for ICU survivors. Validity not established.[5]
Hip Flexion	2-/5	2-/5	4/5	4+/5	
Hip Abduction	2+/5	2+/5	4-/5	4-/5	
Hip Adduction	2+/5	2+/5	4-/5	4-/5	
Knee Flexion	3-/5	3-/5	4/5	4+/5	
Knee Extension	2+/5	2+/5	4-/5	4+/5	
Ankle Dorsiflexion	4/5	4/5	4+/5	4+/5	
Ankle Plantarflexion	4/5	4/5	4/5	5/5	
Observational Gait Analysis					
Distance (feet)	Unable to perform		18 feet with forearm crutches, modified independent using a 4-point gait pattern		Reliable as long as the measurement obtained from successive and repeated use of the instruments is consistent.[8]
Sitting Balance					
Static	Fair, able to sit at edge of bed with PT in front of patient, stabilizing lower extremities.		Normal, able to maintain steady balance without handheld support		Unknown reliability and validity.[6] Measure would be reasonably reliable and valid for the purpose of this case due to consistent grading scales.
Dynamic	Poor, able to resist light perturbations to core while stabilizing self with bilateral upper extremities		Fair+, Patient able to maintain balance with reaching/perturbations, no handheld support		
Standing Balance					
Static	Unable to perform		Good, able to maintain steady balance with forearm crutches		Unknown reliability and validity.[6] Measure would be reasonably reliable and valid for the purpose of this case due to consistent grading scales.
Dynamic	Unable to perform		Fair+, with forearm crutches, patient can accept moderate challenge		
Functional Independence Measure					
Transfers	1 – dependent		3 – Moderate assistance		Excellent motor test-retest reliability with elderly adults and patients with spinal cord injuries (SCI). There is not test-retest information regarding patients who are middle-aged or who have other factors related to the patient in this case report. There is information on
Stairs	0 – not tested (unable)		1– Total assistance		
Locomotion	0 – not tested (unable) Distance: 0 feet		1 – Helper (less than 50 feet) Distance: 1 (less than 50 feet)		

			inter/intrarater reliability for "various diagnoses" which is excellent overall consistency between raters across patients with different diagnosis and levels of impairment.[7]
Aerobic Endurance			
Standing Tolerance (using stopwatch)	Unable to Perform	100 seconds with bilateral upper extremity support on forearm crutches	Unknown reliability and validity. Measure was appropriate for the case due to consistent demonstration of patient progression.

Figure 1. Description and Rationale for Interventions

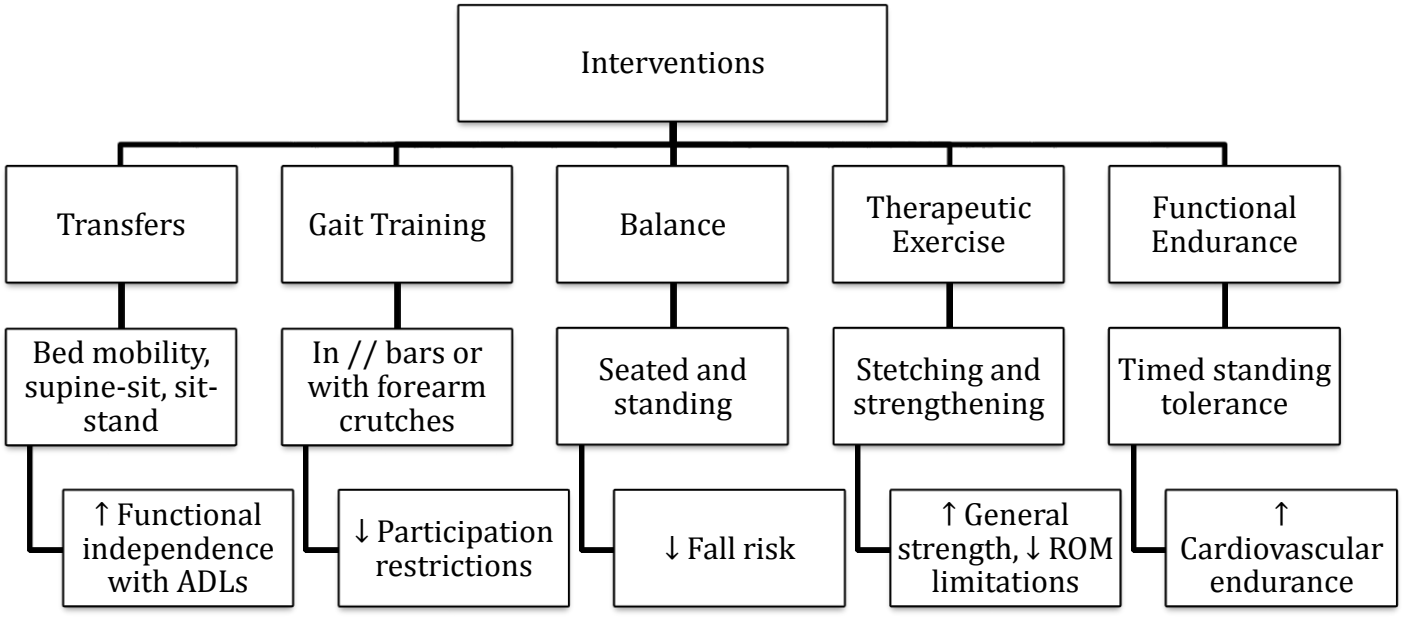


Figure 2. Mobility Equipment

A. Pictured Above: Power wheelchair used for long distance mobility

B. Pictured Above: Forearm Crutches used for ambulation

Figure 3. Ambulation with Forearm Crutches

A. Pictured Above: Patient's sit-stand posture demonstrated from wheelchair

B. Pictured Above: Patient's gait posture demonstrated with use of forearm crutches

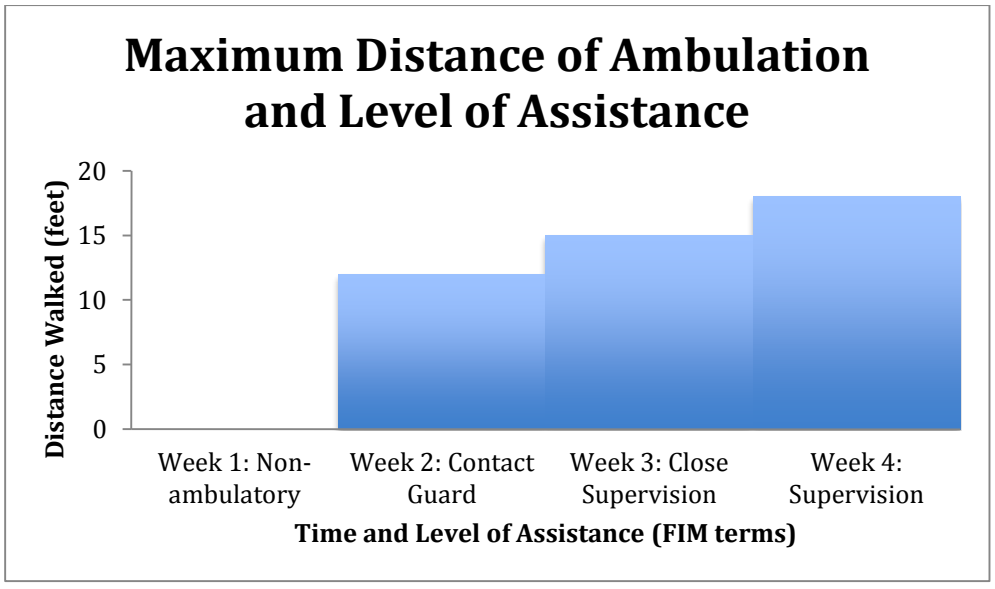
388 Table 2. Interventions Performed by Week

Week	Interventions	General # of Repetitions x Sets Per Session and Level of Assistance
One	**Bed Mobility and Transfers** Rolling Sit ←→ supine Sit←→ stand from w/c to // bars	 3 x 1 Max A Total Assistance with mechanical Lift 2 x 2 Min A – CGA in // bars
	Gait Training and Mobility Wheelchair management	 S, 500 feet x 1
	Balance Training Challenged during transfers, no formal balance training attempted during week one	Ongoing
	Therapeutic Exercise Lower extremity strengthening Lower extremity PROM	 10 x 1 30 seconds x 2
	Standing Tolerance Standing in // bars	 15-20 seconds x 2 with min A
Two	**Bed Mobility and Transfers** Rolling Sit ←→ supine Sit ←→ stand from w/c with forearm crutches	 5 x 2 Mod A with use of bed rails 2 x 1 Mod A with HOB raised to 60 degrees 10 x 1 Min A – CGA with forearm crutches
	Gait Training and Mobility Gait indoors on even surface, with use of forearm crutches	5-8 x 1-2 feet with CGA, with forearm crutches
	Balance Training Modified abdominal sit-ups and trunk rotation seated at edge of bed	10 x 2, no trunk support given during exercise
	Therapeutic Exercise Lower extremity and core strengthening Lower extremity active assisted ROM (AAROM)	 15 x 2, with a 2-3 second hold 15 x 2
	Standing Tolerance Timed standing tolerance	 50-60 seconds x 3 with close S and use of forearm crutches
Three	**Bed Mobility and Transfers** Scooting backward while seated at edge of bed (EOB) Rolling Sit ←→ supine	 2 x 1 CGA 10 x 1 CGA with use of bed rails 3 x 1 Mod A with sit → supine, Min A with supine → sit with HOB raised to 60 degrees
	Gait Training and Mobility Gait indoors on even surface, with use of forearm crutches	10-15 x 2 feet with close S, use of forearm crutches
	Balance Training Modified abdominal sit-ups and trunk rotation seated at edge of bed	20 x 2, no trunk support given during exercise
	Therapeutic Exercise Lower extremity and core strengthening	 20 x 2, with a 5 second hold and abdominal bracing throughout exercise

	Lower extremity AROM and PROM	30 sec x 3
	Standing Tolerance Timed standing tolerance	70-100 seconds x 2 with and without forearm crutches (bilateral upper extremity support at edge of counter) with supervision
Four	**Bed Mobility and Transfers** Scooting at EOB Rolling Sit ←→ supine Sit ←→ stand	 3 x 1 Mod I with bed rails 10 x 2 Mod I with bed rails 3 x 2 Sit → supine: Mod A Supine → sit: S with HOB raised to approximately 30 degrees Mod I with forearm crutches
	Gait Training and Mobility Gait indoors on even surfaces and outdoors on uneven surfaces	18 feet x 2 with S and use of forearm crutches
	Balance Training Seated and standing balance assessment	10 seconds x 2 Eyes open / closed, with and without perturbations. Pt stood with forearm crutch support
	Therapeutic Exercise Lower extremity and core strengthening Lower extremity ROM	20 x 2 with a 5 second hold 30 sec x 3
	Standing Tolerance Timed standing tolerance	90 seconds x 3 with and without forearm crutches (bilateral upper extremity support at edge of counter), S – Mod I

← →: to and from; **// bars:** parallel bars; **Mod I:** modified independent; **S:** supervision; **CGA:** contact-guard assistance; **Min A:** minimal assistance; **Mod A:** moderate assistance; **Max A:** maximal assistance; **PROM:** passive range of motion, **AAROM:** active-assisted range of motion, **AROM:** active range of motion, **HOB:** head of bed

Figure 4. Maximum Distance of Ambulation and Level of Assistance



Appendices

Appendix 1. Medications and Indications

Medication	Indication
Folic Acid	Vitamin
Levothyroxine	Hypothyroidism
Multivitamin	Vitamin
Myrbetriq	Overactive bladder
Norco	Pain
Pravastatin	High cholesterol
VESIcare	Overactive bladder
Tylenol	Pain
Ascorbic acid	Antioxidant
Aspirin	Pain
Carvedilol	Hypertension
Ceftriaxone	Antibiotic – Urinary Tract Infection
Vitamin D	Vitamin D deficiency
Colace	Constipation
Duloxetrine	Depression
Lasix	Edema and Hypertension
Iron Polysaccharide	Iron-Deficiency Anemia
Levalbuterol	Bronchospasm
Lisinopril	Hypertension and Heart Failure
Lorazepam	Anxiety
Zofran	Nausea and Vomiting
Polyethylene	Constipation
Coumadin	Deep Vein Thrombosis

Appendix 2. Systems Review

Cardiovascular/Pulmonary
Impaired High blood pressure controlled with medication.
Musculoskeletal
Impaired Range of motion: The patient displayed bilateral ankle dorsiflexion restriction, with left more limited than the right, bilateral limitations in knee flexion and extension, and hip flexion secondary to pain. She reported having muscular contractions for several years. Bilateral lower extremity strength was generally impaired. Posture: This patient demonstrated a forward head and rounded shoulders. Standing posture could not be assessed at the time of evaluation.
Neuromuscular

Impaired Decreased sitting balance, unable to assess standing balance.
Integumentary
Unimpaired
Communication
Unimpaired
Affect, Cognition, Language, Learning Style
Unimpaired The patient demonstrated to be alert and oriented to person, place and time. Level of consciousness was noted as alert, following commands and answering questions 100% of the time.

404

405 Appendix 3. Short-term and Long-term Goals

Short-term Goals: to be met in one week	Long-term Goals: to be met by discharge
1. In one week, patient will require minimum assistance (25% or less) with bed mobility using the least restrictive assistive device in order to prepare for safe transfers at home.	1. Patient will be considered modified independent according to the functional independence measure (FIM) with bed mobility such as rolling/scooting, sit ←→ supine using the least restrictive assistive device in order for safe mobility upon discharge.
2. In one week, patient will be able to safely stand using forearm crutches for 2 minutes in order prepare for safe participation in activities of daily living.	2. Patient will be modified independent with transfers using the least restrictive assistive device in order for safe participation in ADLs upon discharge.
3. In one week, patient will be able to safely ambulate 15 feet with contact guard using forearm crutches in order to improve functional endurance.	3. Patient will be able to walk with modified independence using the least restrictive assistive device for 150 feet upon discharge in order for safe home and community ambulation upon discharge.
4. In one week, patient will be able to transfer from bed to chair without the use of mechanical lift in order to prepare for transferring safely at home.	4. Patient will be modified independent using the power wheelchair for 300 feet in order for safe home and community mobility upon discharge.
5. In one week, patient will be able to sit at edge of bed with supervision for 5 minutes without loss of balance for safe	5. Patient will be able to sit at edge of bed while performing functional tasks for 15 minutes without assist or loss of balance

participation in ADLs.	for safe participation in ADLs and return to work upon discharge.
	6. Patient will be independent with her home exercise program in order to maintain functional endurance and continue to increase strength upon discharge.
	7. Patient will be able to stand with modified independence for 10 minutes at counter while performing a functional task without needing a seated rest break due to fatigue upon discharge.

Appendix 4. FIM Instrument Scoring Criteria[7]

FIM Instrument Scoring Criteria:	
No Helper Required	
Score	**Description**
7	Complete Independence
6	Modified Independence (patient requires use of device, but no physical assistance)
Helper (Modified Dependence)	
Score	**Description**
5	Supervision or Setup
4	Minimal Contact Assistance (patient can perform 75% or more of task
3	Moderate Assistance (patient can perform 50% to 74% of task
Helper (Complete Dependence)	
Score	**Description**
2	Maximal Assistance (patient can perform 25% to 49% of task)
1	Total Assistance (patient can perform less than 25% of the task or requires more than one person to assist)