# Efficacy of NMES Combined with Traditional Physical Therapy for a 67-Year-Old Male Following Multilevel Cervical Laminectomy and Fusion for Cervical Myelopathy

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**Abstract**

**Background and Purpose**

Cervical myelopathy is a progressive condition caused by spinal cord compression and is a common source of neurological dysfunction in older adults. Even after surgical decompression, some individuals continue to demonstrate persistent weakness, sensory impairment, and functional limitations that interfere with daily activities. Neuromuscular electrical stimulation (NMES) has been used in neurological rehabilitation to facilitate muscle activation and improve motor recruitment when voluntary contraction is limited. The purpose of this case report is to explore the integration of NMES with task-specific and functional training in an outpatient physical therapy setting to address persistent upper extremity weakness and functional limitations in a 67-year-old male following decompressive cervical fusion for cervical myelopathy.

**Case Description**

The patient was a 67-year-old male with a history of cervical myelopathy, type 2 diabetes mellitus with associated polyneuropathy, hypertension, hyperlipidemia, vertigo, and sensorineural hearing loss. Approximately 10 months prior to the current episode of care, he developed symptoms consistent with cervical myelopathy, including gait unsteadiness, multiple falls, neck pain, paresthesia of the hands, decreased dexterity, and dropping objects. Imaging demonstrated increased cervical kyphosis and multilevel spinal cord compression at C4-C6, and he subsequently underwent cervical decompression and fusion. After an earlier course of outpatient rehabilitation, he returned to physical therapy 3 months after discharge because of

persistent right upper-extremity weakness. Initial examination demonstrated marked right shoulder and elbow weakness, impaired scapular stabilizer strength, reduced cervical and shoulder active range of motion, diminished sensation in the C5-T1 dermatomes, absent right biceps and brachioradialis reflexes, reduced grip and pinch strength, slowed dexterity on the Nine-Hole Peg Test, and self-reported disability on the Neck Disability Index and QuickDASH. The treatment plan emphasized NMES paired with active movement, neuromuscular re-education, therapeutic exercise, manual therapy as an adjunct, and home exercise instruction.

**Outcomes**

The patient was re-evaluated at days 30 and 60. Objective findings included improvements in right shoulder active range of motion, such as flexion increasing from 60 degrees to 105 degrees, and abduction increasing from 55 degrees to 110 degrees. Improvements in strength were noted predominantly in the scapular stabilizers and the forearm, with rhomboids improving from 2+/5 to 4/5 and middle trapezius from 3-/5 to 4/5. Elbow flexion improved from 2+/5 to 3/5, and forearm supination improved from 2-/5 to 3-/5. Grip and pinch strength demonstrated variable improvement as tip pinch increased from an average of 8 to 18 pounds.

The self-reported outcome measures show minimal improvement, with the Neck Disability Index decreasing from 36% to 32% and the QuickDASH from 43% to 34.1%. Both outcomes did not meet the minimal detectable change threshold, indicating improvements may not be clinically meaningful. Although the patient did achieve primarily functional-related goals like decreased pain, improved work-related activities, lifting ability, and shoulder active range of motion, higher-level functional goals were partially met.

## Discussion

This case report highlights that using a multimodal approach incorporating neuromuscular electrical stimulation (NMES), task-specific training, and strengthening may support improvements in active range of motion, motor control, and functional use of the upper extremity following cervical myelopathy and surgical decompression with fusion. During outpatient physical therapy, NMES was utilized to facilitate motor activation, particularly for elbow flexion and forearm supination, when paired with active movement, aligning with research supporting the role of NMES in enhancing motor unit recruitment in neurological populations.

Functional improvements, including feeding and functional reaching, suggest the combination of NMES with task-specific training may enhance carryover into daily activities. However, persistent deficits in proximal strength and incomplete achievement of clinically meaningful self-reported outcome measures highlight the complexity of recovery in this population, especially in the presence of other comorbidities like diabetic polyneuropathy and chronicity of spinal cord compression.

Overall, the findings from the case study suggest NMES may be a useful adjunct within a multimodal approach to physical therapy interventions. Continued therapy and further research are needed to optimize outcomes and determine their long-term effectiveness in individuals with cervical myelopathy.

## Background and Purpose

Cervical myelopathy (CM) is a progressive degenerative condition characterized by a compressive force on the spinal cord because of age-related changes in the cervical spine. [13, 21]. Recognizing CM early is crucial, as evidence suggests that timely diagnosis and intervention can significantly influence outcomes and prevent long-term disability. [5, 21] Although the prevalence remains unclear, recent literature suggests CM is the most common cause of spinal cord dysfunction in adults and a significant contributor to neurological impairment. [5, 13, 21] Epidemiological findings further indicate an increased incidence among males, with a typical presentation later in adulthood, at an average age of 64 years. [12] According to Baucher et al., the increased prevalence among men has been hypothesized to be related to occupational and environmental factors, including repetitive loading and heavy manual labor. [2, 21]

Electrophysiological findings suggest that the anatomical level of cervical involvement varies with age, where older adults more commonly demonstrate involvement in the upper cervical segments, and younger individuals in the lower cervical segments. [21]Cervical myelopathy arises from structural and biomechanical changes of the cervical spine that progressively narrow the spinal canal and place stress on the spinal cord. [21] Degenerative changes associated with cord compression include intervertebral disc degeneration, osteophyte formation, facet joint arthropathy, ligamentum flavum hypertrophy, and ossification of spinal ligaments. [21] Both static and dynamic mechanisms contribute to disease development and progression. [10] Static factors include acquired or congenital conditions that narrow the spinal canal, such as congenital stenosis, degenerative disc disease, ossification of the ligamentum flavum, ossification of the posterior longitudinal ligament, spondylosis, and osteophyte formation along the vertebral bodies. [12] In contrast, dynamic factors include movement-dependent biomechanical changes that compress, irritate, or shear the spinal cord, such as degenerative spondylolisthesis, physiologic narrowing of the spinal canal, and sprain or stretch of the spinal cord with movements like flexion and extension. [12]

Prolonged compression of the spinal cord can contribute to neurological and vascular issues, including ischemia, neurological inflammation, demyelination, and axonal injury. [12] Neurological symptoms may involve upper and lower extremities, including the hands and feet, leading to difficulty ambulating. [13] Emerging research highlights the relevance of neuroplasticity, suggesting adaptive neural changes influence symptom presentation and recovery potential. [3] Bonosi et al. emphasize that functional outcomes following surgical decompression may depend partly on the spinal cord's capacity for neuroplastic adaptation. [3]

Although cervical myelopathy and spinal cord injuries have differing etiologies, both conditions involve structural compromise of the cervical spinal cord, resulting in impaired neuromuscular transmission. The chronic compression observed in patients who suffer from cervical myelopathy produces an upper motor neuron dysfunction, reduced voluntary motor unit recruitment, and progressive muscle atrophy, which are pathophysiological features similar to those seen in incomplete spinal cord injury (SCI). Rehabilitation strategies shown to restore muscle activation and hypertrophy in SCI may have translational relevance for individuals with CM. Neuromuscular electrical stimulation (NMES) is utilized in physical therapy rehabilitation to elicit involuntary muscle contractions when voluntary activation is impaired. NMES promotes muscle fiber recruitment to mitigate muscular atrophy. By generating repeated contractions, NMES provides a stimulus sufficient to support muscle hypertrophy in populations with neurological compromise. In the spinal cord injury literature, resistance-based NMES protocols are an effective strategy for producing a meaningful increase in muscle cross-sectional area and overall muscle mass. [7, 8] Similarly, a systematic review by Fenton et al. identified electrical stimulation-based training paradigms as a primary strategy for increasing muscle mass in persons with motor-complete SCI. [6] These findings support the physiological rationale for incorporating NMES in conditions characterized by reduced neural drive and muscle atrophy. Therefore, evidence supports the use of NMES to enhance muscle mass and motor recruitment in SCI populations, providing a physiological rationale for its use in patients with cervical myelopathy presenting with upper extremity weakness.

The purpose of this case report is to describe the effects of a multimodal approach to an outpatient physical therapy program, including neuromuscular electrical stimulation, task-specific training, and strengthening to address upper extremity weakness and functional limitations in a 67-year-old male following decompressive cervical fusion for cervical myelopathy. Prior to preparing this case report, consent was obtained from the patient to proceed with data collection. All information contained in this case report meets the Health Insurance Portability Accountability Act (HIPPA) requirements of the clinical agency for disclosure of protected health information. This case report was completed under the direction of the Department of Physical Therapy and with the oversight of the College of Graduate Studies at Central Michigan University.

## Case Description

### *Patient History and Review of Systems*

A 67-year-old male presented to outpatient physical therapy with primary complaints of right upper extremity weakness, decreased coordination, and difficulty performing functional tasks such as feeding and grooming. He has a past medical history that consists of hypertension controlled with medication, mixed hyperlipidemia, type 2 diabetes mellitus associated with polyneuropathy, leukocytosis, vertigo, benign non-nodular prostatic hyperplasia, and sensorineural hearing loss managed with hearing aids. His medication regimen included agents for hypertension, hyperlipidemia, neuropathic pain, and diabetes management.

Approximately 10 months before the current episode of care, the patient presented to his physician with symptoms that led to a diagnosis of cervical myelopathy, such as unsteady gait, multiple falls, significant neck pain, paresthesia of his hands with dropping objects, and loss of dexterity. Electrodiagnostic testing at that time revealed findings consistent with peripheral neuropathy. Cervical magnetic resonance imaging demonstrated increased cervical kyphosis and multilevel spinal cord compression posterior to the C4, C5, and C6 vertebral levels.

The patient underwent cervical fusion with decompression. The surgical procedure included decompressive laminectomies from C4 through C7 with bilateral stabilization at C3–C4 and C6–C7. Postoperatively, the patient began outpatient physical therapy one month following surgery and completed 32 therapy visits over five months. After discharge from therapy, he returned to outpatient physical therapy three months later for continued rehabilitation due to persistent right upper extremity weakness. This ongoing care highlights the importance of comprehensive rehabilitation in recovery and the patient's commitment to regaining function.

*Clinical Impression #1*

The patient presented to outpatient physical therapy following a decompressive cervical fusion performed for pre-operative diagnoses of cervical stenosis, cervical spondylosis, and cervical kyphosis with spinal cord compression at the C4-C6 levels, and myelopathy. Based on the chart review and the patient interview, persistent neurological and musculoskeletal impairments were anticipated following surgery, particularly involving upper extremity strength and motor performance.

Given the patient’s diagnosis of cervical myelopathy and surgical history, anticipated impairments included decreased cervical range of motion, upper extremity weakness, sensory deficits in the upper extremity dermatomes, and impairments in dexterity and coordination affecting functional hand use. These impairments were expected to contribute to functional limitations in tasks requiring upper extremity strength and motor control, including carrying objects, maintaining arm position during work-related computer tasks, performing household activities, and participating in community activities. The patient’s report of right upper extremity weakness, difficulty with object manipulation, and pain during lifting further supported the expectation of persistent neuromuscular deficits affecting daily function.

To objectively evaluate these anticipated impairments, a comprehensive examination of cervical mobility, upper extremity strength, sensation, and motor performance was planned. Manual muscle testing was selected to assess strength deficits in the shoulder, elbow, and scapular stabilizers, while grip and pinch strength testing were utilized to quantify functional hand strength. Additional testing of upper extremity coordination and dexterity was planned to evaluate fine motor control and functional hand use.

To further quantify the patient's level of functional limitation and monitor response to intervention, standardized outcome measures were selected. The Neck Disability Index (NDI) was administered to evaluate perceived disability related to cervical spine function. The Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) questionnaire was used to assess functional limitations associated with upper-extremity impairments. Additionally, the Nine-Hole Peg Test was utilized as a performance-based measure to evaluate hand dexterity and coordination. These outcome measures provide both subjective and objective insight into the patient's functional change throughout rehabilitation. This patient represents a valuable case for examination due to the persistence of upper extremity weakness and functional limitations following multilevel cervical decompression and fusion for cervical myelopathy.

*Examination*

*Posture.* Postural assessment was conducted in both seated and standing positions. In seated, the patient demonstrated posterior pelvic tilt, increased thoracic kyphosis, bilateral scapular protraction, increased lumbar lordosis, and right shoulder elevation. In standing, asymmetries included left hip elevation and a left toe-out position. These findings suggest altered postural alignment and compensatory positioning that may contribute to inefficient upper quarter mechanics during functional activity. Evidence supporting the reliability and validity of observational posture assessment is limited, so these findings are best interpreted as descriptive clinical observations rather than precise measurements. [15]

*Active Range of Motion.* Active range of motion (AROM) of the cervical spine and upper extremities was assessed with a goniometer at the initial examination. Goniometric assessment is commonly used in clinical practice to quantify mobility limitations, and systematic reviews support acceptable reliability and validity for cervical range-of-motion measurement when standardized procedures are used. [19, 26, 27] At the initial evaluation, cervical AROM was globally restricted; flexion and extension were limited to 20 degrees, bilateral side bend was limited to 10 degrees, and bilateral rotation was limited to 35 degrees. Shoulder active range of motion was reduced on the right compared to the left. Left shoulder active range of motion measured 135 degrees of flexion, 140 degrees of abduction, 55 degrees of external rotation, and internal rotation to the L2 vertebral level. Right shoulder active range of motion measured 60 degrees of flexion, 55 degrees of abduction, 40 degrees of external rotation, and 45 degrees of internal rotation. These findings indicate clinically meaningful mobility limitations of the cervical spine and right upper extremity that likely interfered with reaching, lifting, overhead activity, and sustained arm positioning. [16, 26]

*Strength.* Manual muscle testing was formally assessed at the initial evaluation for baseline measurements of upper-extremity and scapular muscle strength. Manual muscle grades are typically assigned on a 0-to-5 scale, with lower scores indicating decreased ability to move through the range of motion against gravity or resistance. Evidence supports the use of manual strength testing, although reliability varied by muscle group, examiner technique, and testing standardization. [4] Deficits were identified throughout the right upper extremity. Weakness was most pronounced in shoulder flexion and abduction, each graded 3-/5, and external rotation, graded 2-/5. Scapular stabilizer weakness was also present, with the right rhomboids and middle trapezius each graded 3-/5. Elbow flexion was impaired, with right biceps strength graded 2+/5, brachialis 3+/5, and brachioradialis 2-/5, whereas wrist flexion and extension were preserved at 5/5. Forearm supination and pronation were also impaired in the right upper extremity. The patient was positioned with the wrist in a neutral position; left forearm supination and pronation graded 5/5, right pronation 3+/5, and supination 2-/5. The patient also required assistance to maintain the right upper extremity in the test position for elbow flexion, suggesting reduced motor control and limited muscular capacity. Collectively, these findings support significant proximal weakness that affects the functional use of the right upper extremity.

*Grip and Pinch Strength.* Grip and pinch strength testing were used to measure functional hand strength and asymmetry between extremities. Hand dynamometry is widely used in rehabilitation and has demonstrated good reliability and validity for measuring grip performance. [4] At the initial examination, average grip strength measured 37 pounds on the left and 28 pounds on the right. The average tip pinch measured 14 pounds on the left and 8 pounds on the right, while the key grip was relatively symmetrical at 22 pounds on the left and 23 pounds on the right. Patient required assistance to hold arm in test position with shoulder in neutral and elbow at 90 degrees of flexion. These findings indicate decreased force production of the right hand, particularly for grip and tip pinch tasks, which likely affected object manipulation and carrying activities.

*Sensation.* Sensation was assessed using a pinwheel to evaluate sharp sensation across dermatomal distributions of the right and left upper extremity. Sharp sensation testing is a standard component of a neurological examination used to assess small-fiber sensory function and identify segmental sensory deficits, although accuracy can vary based on patient response and examiner technique. [15] At the initial examination, diminished sensation was identified across multiple right upper extremity dermatomes, including C5 through T1. These findings indicate widespread sensory involvement affecting both proximal and distal portions of the right upper extremity.

*Reflexes.* Deep tendon reflex testing was performed as part of the neurological examination. Deep tendon reflex assessment is a standard clinical tool used to help identify neurological dysfunction involving peripheral nerves, spinal cord segments, and descending pathways, although interpretation depends on the examiner's technique and grading consistency. [15] At the initial examination, the right biceps and brachioradialis reflexes were absent, whereas triceps reflexes were preserved bilaterally. Lower extremity reflexes were within functional limits, with quadriceps reflexes mildly reduced bilaterally and Achilles reflexes preserved. These findings suggest altered neurological function of the involved upper extremity and support neural impairment affecting the C5-C6 distribution.

*Dexterity and Coordination.* Upper-extremity dexterity was assessed using the Nine-Hole Peg Test, a standardized timed measure of fine motor coordination and finger dexterity. The Nine-Hole Peg Test has demonstrated high interrater reliability and is commonly used to assess manual dexterity in adults. Standardized measures were administered to evaluate the patient's motor performance and patient self-reported functional abilities. At the initial examination, the patient completed the test in 24.76 and 26.51 seconds with the left hand and 34.47 and 31.08 seconds with the right hand. Slower performance on the right indicated impaired fine motor coordination and reduced hand dexterity of the involved upper extremity. [17]

*Self-Reported Functional Outcome Measures.* Self-reported outcome measures were administered to assess the patient's perceived disability related to the cervical spine and upper extremities. The Neck Disability Index is a 10-item questionnaire developed to assess self-rated disability associated with neck pain and has established reliability and validity in patients with cervical dysfunction. [25] The QuickDASH is an 11-item questionnaire derived from the DASH and has demonstrated good validity and reliability for upper-extremity disorders. [9] At the initial examination, the patient scored 36% on the Neck Disability Index and 43% on the QuickDASH, indicating meaningful perceived disability related to neck and upper extremity function. The results were consistent with the patient's reported difficulty performing work-related tasks, carrying objects, sleeping comfortably, and completing activities that require sustained upper-extremity use. [9, 25]

*Clinical Impression #2*

Findings from the initial examination were consistent with persistent neurological and musculoskeletal impairments following cervical decompression and fusion for cervical myelopathy. As expected, the patient demonstrated right upper-extremity weakness, reduced cervical mobility, sensory disturbance, and impaired right upper extremity functional performance. Objective strength testing revealed notable deficits throughout the right upper extremity, particularly in the shoulder and scapular stabilizers. These findings indicate substantial proximal upper-extremity weakness that affects functional use of the arm.

Additional examination findings further supported impaired upper-extremity motor performance. Grip and pinch strength testing demonstrated asymmetry between extremities, indicating impaired fine motor coordination and reduced hand function. The patient additionally required assistance to stabilize the right upper extremity during testing, which reflects limited strength and motor control. Cervical active range of motion was globally limited, which was consistent with the patient's surgical history and likely contributed to altered movement strategies during functional tasks.

Neurological findings suggest a more complex presentation than postoperative weakness alone. Sensory testing revealed diminished sensation across multiple right upper-extremity dermatomes, and reflex testing demonstrated absent right biceps and brachioradialis reflexes with preserved triceps reflexes. These findings suggest contributions from both central and peripheral mechanisms. The patient's known diabetic polyneuropathy likely contributed to distal sensory changes and hyporeflexia, whereas the pronounced proximal weakness impaired motor performance, and persistent functional deficits were more consistent with residual effects of cervical myelopathy and postoperative neural compromise. This overlap between central and peripheral neurological involvement is clinically important because it may influence recovery potential, expected functional gains, and rehabilitation planning.

Examination findings indicate that the patient's impairments substantially affected functional performance. Right upper-extremity weakness, reduced coordination, sensory loss, and limited cervical mobility contributed to difficulty with work-related computer tasks, maintaining arm position on a desk, carrying objects, manipulating items, and sleeping comfortably. Elevated Neck Disability Index and QuickDASH scores further supported meaningful activity limitations. In addition, the patient reported a history of falls and feelings of unsteadiness, suggesting potential balance and safety concerns that warranted monitoring during rehabilitation.

Based on the examination findings and the patient's stated goals, the primary long-term rehabilitation goals were to reduce pain to less than 3/10, improve tolerance for usual work activities with minimal to no difficulty, decrease difficulty lifting objects from the floor, improve rhomboid and middle trapezius strength to 4-/5 for lifting and arm positioning during work and overhead activities, improve right shoulder flexion, abduction, and elbow flexion strength to 4-/5 for reaching and lifting activities, improve right shoulder abduction to 110 degrees for overhead function, restore grip and pinch strength to levels more comparable to the left, and improve QuickDASH score to 30% or less. These goals aim to improve functional participation in work-related, household, and community activities.

Factors that were expected to positively influence the patient's outcomes included prior participation in therapy, intact cognition, ability to actively participate in treatment, and motivation to improve upper-extremity function. Factors that could negatively influence the outcome included the chronicity of symptoms, extent of neurological involvement, postoperative neural compromise, and comorbidities, including diabetic polyneuropathy, which may limit the rate and extent of recovery.

Skilled outpatient physical therapy was indicated to address neuromuscular performance, upper-extremity function, postural control, and task-specific activity tolerance. The plan of care will emphasize neuromuscular re-education, progressive resistance training, postural correction, and task-specific functional retraining. Given the examination findings of reduced shoulder flexion, abduction, external rotation, forearm supination, and diminished grip force, NMES will be used to facilitate motor unit recruitment and augment active contraction during strengthening tasks. [6, 7, 8, 18] This approach was selected to enhance neuromuscular activation in the presence of persistent weakness influenced by central motor pathway compromise and peripheral neuropathic contributions.

*Interventions*

Interventions were designed to address persistent right upper-extremity weakness, impaired motor control, reduced shoulder mobility, and limited functional use of the arm following cervical decompression and fusion for cervical myelopathy. The treatment plan emphasized a combination of neuromuscular electrical stimulation (NMES), therapeutic exercise, neuromuscular re-education, and manual therapy to facilitate motor recruitment while practicing task-specific upper-extremity movement. NMES was selected because electrical stimulation can augment voluntary contraction, improve motor recruitment, and support motor retraining in individuals with neurological weakness when paired with active movement. Literature has described NMES as a strategy to enhance motor unit recruitment and support muscle performance when combined with active training, particularly in neurological populations. [3, 5, 6, 7, 8, 11, 12, 18]

*Neuromuscular Electrical Stimulation.* NMES was applied during active movement to the involved upper extremity. Stimulation parameters included symmetrical biphasic waveform at 35 Hz, pulse duration 160-180 microseconds, 2-5 second ramp, with a duty cycle of 10 seconds on and 30-50 seconds off, and approximately 15-25 minutes per session. Pairing NMES with voluntary movement was intended to promote greater activation of weak muscle groups and improve motor performance during functional upper-extremity tasks. [6, 7, 8, 12, 18] During early sessions, the patient demonstrated improved ability to maintain elbow flexion and improved forearm supination with NMES activation. The patient tolerated NMES well, reporting no pain, although occasional muscle soreness was noted following 1 treatment session. Over time, improved motor control and active range of motion were observed during NMES-assisted tasks.

NMES was consistently paired with therapeutic exercise and neuromuscular re-education to maximize carryover into functional movement and was not used as a standalone intervention.

*Therapeutic exercise.* Therapeutic exercise was implemented to improve strength, range of motion, and functional use of the right upper extremity, consistent with evidence supporting progressive resistance training in neurological populations. [5, 12] Exercises included supine elbow flexion/extension, forearm supination/pronation, scapular protraction/retraction, and wrist strengthening, generally performed in 2 sets of 10 repetitions. As the patient progressed, exercises were advanced to cane-assisted bicep curls, shoulder flexion, and chest press to increase functional demand. The patient demonstrated good tolerance to therapeutic exercise with gradual improvements in movement quality and strength. Mild post-exercise soreness was reported but did not limit participation. Therapeutic exercise was performed in conjunction with NMES and neuromuscular re-education to reinforce motor activation and functional carry-over.

*Neuromuscular re-education.* Neuromuscular re-education was utilized to improve movement quality, coordination, and active control of the involved upper extremity. This approach aligns with rehabilitation principles emphasizing task-specific motor retraining following neurological impairment. [3, 5] Interventions included supine shoulder flexion/scaption, internal/external rotation, and rhythmic stabilization at 90 degrees of shoulder flexion. Treatment sessions also included verbal cueing and facilitation to assist with proper alignment and movement patterns. The patient demonstrated improved control of forearm supination and elbow positioning over time, though continued cueing was required. Neuromuscular re-education was performed concurrently with NMES and therapeutic exercise to enhance motor learning and functional integration.

*Manual therapy.* Manual therapy was used as an adjunct to address soft tissue restriction and improve tolerance to active movement. Evidence supporting manual therapy following cervical myelopathy surgery is limited; however, literature supports its use as part of a multimodal rehabilitation approach. [1] Techniques included soft tissue mobilization and functional massage to the right biceps in supine (lying on the back with support under the knees). The patient reported decreased stiffness following manual therapy, which improved tolerance to subsequent exercise. No adverse effects were reported. Manual therapy was used in conjunction with NMES and exercise to optimize readiness for active movement rather than as a primary intervention.

The patient demonstrated good participation and overall tolerance throughout the documented intervention period. During an early session, he reported feeling stiffer in the biceps at the start of treatment but denied current pain. During that session, improved active forearm supination was observed with NMES activation, and elbow flexion was performed with a neutral grip rather than the previously observed pronated forearm position. He tolerated new exercises with electrical stimulation well and reported no pain or discomfort with treatment, although he did notice a stretching sensation while holding the cane with the wrist supinated. A brief episode of vertigo occurred during the transition from right sidelying to sitting but resolved within seconds. With the patient's history of vertigo, the episode appeared to be unrelated to the upper-extremity intervention itself.

During a subsequent session, the patient reported muscle soreness after the prior session and stated that the back of his elbow was mildly irritable for approximately one day. However, he denied pain or soreness upon arrival to therapy. He reported he was able to bring a fork to his mouth when holding a plate at chest level, although he remained unable to actively flex the shoulder from below chest level. During treatment, improved forearm supination was again observed, and the patient reported that it felt like he was “getting more range”. Occasional tactile cues were still required to maintain elbow flexion at 90 degrees, with minimal facilitation needed for forearm supination. He tolerated the session well and demonstrated improved elbow flexion active range of motion after treatment, while maintaining a neutral forearm position.

At the re-evaluation, the patient reported no pain in the right arm and described functional improvement since restarting therapy. Specifically, he noted improved ability to lift the arm straight up while lying on his back and improved ability to feed himself while holding a plate at chest level. He also reported that the muscles felt as though they were “getting a good workout” after therapy sessions. These responses suggest that the intervention dosage was sufficient to elicit muscle activation and task practice without excessive symptom provocation. At the same time, residual deficits remained in shoulder strength, dexterity, and activity tolerance, supporting the continued need for skilled therapy.

Other concurrent interventions included home exercise and home management instruction. The progress note documented active range of motion exercises as part of the home program. The treatment plan also included the potential use of therapeutic activities, patient instruction, and symptom-modulating modalities as needed. Frequency and duration were established as 8 to 16 visits over 2 months with periodic re-evaluations, allowing the plan of care to be adjusted based on changes in strength, range of motion, dexterity, pain, and functional performance.

Following re-evaluation, interventions continued to emphasize neuromuscular electrical stimulation, task-specific functional training, and progressive therapeutic exercise to address persistent right upper extremity weakness, impaired motor control, and functional limitations. Interventions were progressed based on patient tolerance and observed improvements in motor performance.

*Neuromuscular Electrical Stimulation.* NMES was continued to facilitate motor unit recruitment and improve voluntary muscle activation in the presence of persistent neurological weakness, consistent with evidence supporting its use in neurological populations. 6, 7, 8, 18 NMES was applied to the right upper extremity during active movement tasks. Interventions included seated elbow flexion and extension with the arm supported on a table, as well as forearm supination and pronation exercises. The patient demonstrated continued improvement in motor activation over the course of treatment. During sessions, improved forearm supination was observed both with and without electrical stimulation. By later sessions, the patient demonstrated improved ability to activate elbow flexion with forearm supination and required less external facilitation. The patient consistently tolerated NMES without reports of pain, and no adverse effects were noted. NMES was consistently combined with therapeutic exercise and task-specific training to promote carryover into functional activities.

*Therapeutic Exercise and Functional Training.* Therapeutic exercise and task-specific training were progressed to improve strength, coordination, and functional use of the right upper extremity. This approach aligns with evidence supporting progressive, task-oriented rehabilitation in individuals with neurological impairments. [5, 12] Interventions progressed from isolated strengthening to more functional activities. Exercises included NMES with bicep curls, forearm supination/pronation tasks, and progressive reaching activities. Functional training included picking up and placing down lightweight (1 pound) and stacking objects at varying shelf heights to simulate activities of daily living. Sessions also incorporated multilevel reaching and object manipulation tasks to improve coordination and functional arm use. The patient demonstrated progressive improvement in functional performance. He reported improved ability to bring his hand to his mouth and brush his teeth using the affected upper extremity. Over time, he progressed from difficulty lifting objects to performing light functional tasks, including stacking objects at different heights. At discharge, he demonstrated improved ability to reach overhead and manipulate objects, although limitations remained with heavier lifting tasks. Therapeutic exercise and functional activities were performed concurrently with NMES and neuromuscular re-education to maximize motor learning and functional carryover.

*Neuromuscular Re-education.* Neuromuscular re-education continued to address deficits in coordination, movement quality, and motor control. This approach is supported by literature emphasizing task-specific motor retraining following neurological impairment. [3, 5] Interventions included proprioceptive neuromuscular facilitation (PNF) patterns (D1 and D2) performed in sidelying, as well as multidirectional reaching tasks in standing. Emphasis was placed on controlled movement patterns, particularly during elbow flexion/extension and forearm supination/pronation. The patient demonstrated improved coordination and motor control throughout the episode of care. Improved movement quality was observed during reaching tasks and functional activities, with decreased need for external cueing over time. However, deficits in coordination and strength persisted at discharge. Neuromuscular re-education was integrated with NMES and functional training to enhance motor control and promote functional independence.

*Patient Response and Progression.* The patient demonstrated consistent participation and tolerance throughout the episode of care. At re-evaluation, the patient reported no pain in the right arm and stated he felt he had improved since restarting therapy. He specifically reported improved ability to lift the arm straight upward while lying on his back and improved ability to feed himself while holding a plate at chest level. He also reported that his muscles felt as though they were "getting a good workout" after therapy sessions. During later sessions, he reported minimal to no pain with only occasional mild discomfort (less than 1.5/10) during lifting tasks. Functionally, the patient demonstrated meaningful improvements. He progressed from difficulty initiating movement against gravity to the ability to bring his hand to his mouth, brush his teeth, and perform light object manipulation tasks. At discharge, he demonstrated improved active range of motion (shoulder flexion up to approximately 105 degrees and abduction to 110 degrees) and improved strength in scapular stabilizers and distal upper-extremity musculature. Despite these improvements, limitations remained in proximal strength and the ability to lift heavier objects, indicating incomplete recovery of upper-extremity function.

*Concurrent Interventions.* Additional interventions included a home exercise program (HEP) to reinforce gains made during therapy sessions. The HEP consisted of wall active-assisted shoulder flexion and scaption, supine cane-assisted shoulder exercises, seated bicep curls, and standing shoulder movements. The patient demonstrated adherence to the home program and reported actively practicing arm movements outside of therapy sessions.

**Outcomes**

The patient was re-evaluated approximately 30 days and 60 days after the initial evaluation. Outpatient physical therapy focused on right upper extremity weakness, impaired motor control, reduced shoulder mobility, and limited functional use of the arm.

*Posture.* Postural findings remained largely unchanged at re-evaluation, with continued presence of thoracic kyphosis and scapular protraction, though improved dynamic scapular control was observed during functional reaching tasks.

*Active Range of Motion.* Right shoulder flexion improved from 60 degrees to 80 degrees at the re-evaluation. At discharge, right shoulder flexion further improved to 105 degrees. Right shoulder abduction improved from 55 degrees to 70 degrees at the first re-evaluation and reached 110 degrees at discharge, demonstrating continued gains toward functional overhead mobility.

*Strength.* Improvements were observed in the scapular stabilizers, with the right rhomboid improving from 3-/5 to 4-/5 at re-evaluation and progressing to 4/5 at discharge. The middle trapezius improved from 3-/5 to 4/5 at re-evaluation and was maintained at discharge. Right forearm supination improved from 2-/5 to 3-/5 at re-evaluation and remained limited at 3-/5 at discharge. Elbow flexion improved from 2+/5 to 3+/5 (with assistance to assume test position) and was recorded at 3/5 at discharge (without assistance to assume test position). However, brachialis and brachioradialis specific manual muscle test was not reassessed at the time of discharge. Shoulder flexion and abduction remained limited throughout the episode of care. Initially, shoulder flexion and abduction were scored 3-/5; by discharge, they remained unchanged, indicating incomplete recovery. Lastly, shoulder internal and external rotation strength was not reassessed at the time of discharge.

*Sensation.* Sensory deficits were not formally reassessed and are assumed to remain unchanged from the initial examination.

*Reflexes.* Reflexes were not reassessed at re-evaluation or discharge.

*Dexterity and Coordination.* Right grip strength improved from 28 pounds to 34 pounds at re-evaluation, both with assistance to maintain the test position. At discharge, grip strength averaged 28 pounds without assistance to maintain the test position, indicating improvement of functional upper extremity use. Tip pinch strength improved from 8 pounds to 14 pounds at re-evaluation and averaged 18 pounds at discharge. Key grip decreased slightly from 23 to 21 pounds at re-evaluation, but he no longer required assistance to maintain the test position, and maintained stable at 21 pounds upon discharge. Nine-Hole Peg Test improved from 34.47 and 31.08 seconds at initial evaluation to 30.10 and 28.90 seconds at re-evaluation, and further to 26.62 and 29.63 seconds at discharge, indicating improved fine motor coordination and dexterity.

*Self-Reported Functional Outcome Measures.* The Neck Disability Index improved from 36% to 34% at re-evaluation, and was 32% at discharge, reflecting a small reduction in perceived disability. The QuickDASH improved from 43% to 38.6% at re-evaluation and was 34.1% at discharge. However, this change did not exceed the reported Minimal Detectable Change (MDC) of 15.9 points, indicating that while improvement was observed, it may not represent a clinically significant change.

*Goals.* The patient met the goal related to pain reduction less than 3 out of 10 and demonstrated improved ability to perform basic functional tasks such as reaching and bringing the hand to the mouth. Strength goals were partially met, with improvements in scapular stabilizers but persistent deficits in shoulder and elbow strength. Grip and pinch strength goals were partially achieved. Range of motion goals were partially met, with meaningful gains in shoulder flexion and abduction, but full functional range of motion was not restored. Functional outcome goals of QuickDASH less than or equal to 30% were not met.

After receiving two months of outpatient physical therapy, the patient demonstrated improvements in range of motion, strength, coordination, and functional use of the right upper extremity. However, he remains limited in functional tasks that require light weight, and strength deficits along the C5 and C6 nerve distribution.

**Discussion**

This case report describes the outcomes of outpatient physical therapy management for a 67-year-old male with right upper extremity weakness and impaired motor control. Symptoms started before cervical decompressive surgery with a spinal fusion for cervical myelopathy and persisted after surgical intervention. At the initial evaluation, deficits were noted in proximal strength, coordination, and dexterity, which limited the patient's ability to perform daily activities like feeding, grooming, lifting, and work-related activities. Overall, the patient made improvements in range of motion, scapular strength, grip and pinch strength, and fine motor coordination. These changes were noted through objective measures, observation of functional activities during treatment, and by self-report from the patient. Despite his improvements, he continued to be limited in proximal muscle strength within the C5 and C6 nerve root distributions, motor control, and functional activities at the time of discharge.

These findings are consistent with the presentation of cervical myelopathy, as individuals often demonstrate persistent neurological deficits in strength, coordination, sensation, and dexterity, even after undergoing surgical decompression. [12, 21] The purpose of surgical intervention is to prevent further neurological decline, rather than restore complete function. [10, 11] Therefore, this may suggest why the patient continued to have persistent impairments. In this case study, other comorbidities such as diabetic polyneuropathy are likely to have contributed to distal sensory deficits and influenced recovery, supporting the presentation of both central and peripheral neurological contributions. [12]

NMES was utilized to facilitate muscle activation due to impaired voluntary muscle recruitment, particularly with elbow flexion and forearm supination. The patient demonstrated improvements in these movements during and after exercises with NMES. This suggests that NMES may have supported motor activation when paired with active movement. This aligns with literature supporting NMES as an effective adjunct to enhance motor unit recruitment and support motor recovery in individuals with neurological impairments. [7, 14, 24]

In addition to using NMES, task-specific and functional training activities were emphasized throughout the patient’s plan of care. Interventions progressed from supported movements to dynamic reaching and object manipulation tasks, which likely contributed to improvements in coordination and dexterity. These findings align with evidence-based research supporting task-specific training as an effective approach to promote motor learning and functional carryover following neurological impairments. [3, 5, 20]

Although improvements were observed, not all outcomes met the minimal detectable change (MDC), indicating perceived improvements may not have been clinically meaningful. [9, 23] This emphasizes the complexity of individuals recovering from cervical myelopathy, where objective improvements in strength and motor performance may not always carry over to meaningful changes in perceived function. Limitations should be considered when interpreting the findings of this case report. Outcome measures such as reflexes and sensation were not reassessed, limiting the ability to evaluate neurological recovery. Additionally, variations in grip strength at discharge may have been influenced by testing conditions or fatigue. Occasional missed therapy sessions due to personal reasons may have affected the consistency of intervention delivery and potentially impacted the patient's progress. Additionally, the patient anticipated the need for further physical therapy later in the year and chose to conserve remaining insurance-covered visits, resulting in earlier discontinuation of care. At the time of discharge, the patient was transitioned to an independent home exercise program to continue progressing strength, motor control, and functional use of the right upper extremity. These factors may have limited the overall intensity and duration of intervention and should be considered when interpreting the patient's outcomes.

Overall, this case report supports the use of a multimodal approach in outpatient physical therapy, including NMES, task-specific and functional training, and strengthening, to address impairments of upper extremity weakness and functional limitations following cervical myelopathy. Although the patient was discharged without full resolution of impairments, the patient demonstrated meaningful improvements in motor control, coordination, strength, and functional performance. These findings support the purpose of this case report, suggesting NMES combined with task-specific functional training and strengthening may be a valuable adjunct in improving upper extremity function in individuals with cervical myelopathy.

Continued research is needed to further understand the specific role of NMES within this population.

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**Table 1.**

Upper Extremity Strength Grades at Initial Evaluation, 30-day Re-evaluation, and 60-day Re-evaluation.

| | **Initial exam Left** | **Initial exam Right** | **Re-evaluation (Day 30), Right** | **Re-evaluation (Day 60), Right** |
|---|---|---|---|---|
| **Shoulder** | | | | |
| Flexion (C5,6) | 5 | 3- | 3- | 3 |
| Extension (C5,6) | | | | |
| Abduction (C6) | 4- | 3- | 3- | 3+ |
| Adduction (C6 | | | | |
| External rotation (C5) | 4+ | 2- | 2- | |
| Internal rotation (C6) | 4+ | 4+ | 4+ | |
| **Scapular** | | | | |
| Rhomboids (C5) | 5 | 3- | 4- | 4 |
| Middle Trapezius | 4+ | 3- | 4 | 4 |
| **Elbow** | | | | |
| Flexion (C6) | 5 | Bicep 2+<br>Brachialis 3+<br>Brachioradialis 2- | Bicep 2+<br>Brachialis 3+<br>Brachioradialis 3- | Bicep 3 |
| Extension (C7) | 5 | 5 | | |
| Pronation (C7,8) | 5 | 3+ | 5 | 5 |
| Supination (C6) | 5 | 2- | 3- | 3- |
| **Wrist** | | | | |
| Flexion (C7,8) | 5 | 5 | | |
| Extension (C7) | 5 | 5 | | |
| Radial Deviation (C7) | 5 | 5 | | |
| Ulnar deviation (C8) | 5 | 5 | | |
| **Grip** (pounds) Trial 1, 2, 3 | 34, 38, 41<br>(Average 37) | 27, 30, 28<br>(Average 28) | 34, 33, 36<br>(Average 34) | 28, 31, 26<br>(Average 28) |
| **Tip Pinch** (pounds) | 16, 12, 14<br>(Average 14) | 10, 9, 6<br>(Average 8) | 14, 14, 16<br>(Average 14) | 22, 18, 16<br>(Average 18) |
| **Key Grip** (pounds) | 24, 21, 22<br>(Average 22) | 24, 24, 22<br>(Average 23 | 20, 22, 22<br>(Average 21) | 21, 21, 22<br>(Average 21) |
| Thumb extension | 5 | 5 | | |
| Finger abduction | 5 | 5 | | |

**Table 2.**

Active Shoulder Range of Motion at Initial Evaluation, 30-day Re-evaluation, and 60-day Re-evaluation.

| | **Initial exam Left** | **Initial exam Right** | **Re-evaluation (Day 30), Right** | **Re-evaluation (Day 60), Right** |
|---|---|---|---|---|
| **Shoulder** | | | | |
| Flexion (C5,6) | 165 | 60 | 80 | 105 |
| Extension (C5,6) | | | | |
| Abduction (C6) | 180 | 55 | 70 | 110 |
| Adduction (C6 | | | | |
| External rotation (C5) | 55 | 40 | | |
| Internal rotation (C6) | L2 | 45 | | |

**Table 3.**

Goals Established at Initial Evaluation.

| Goals established at Initial Evaluation | Met or Not Met<br><br>Re-eval 30 days | Met or Not Met<br><br>Re-eval 60 days (Discharge) |
|---|---|---|
| Patient will report pain less than 3/10. | Met | Met |
| Patient will report ability to perform his usual work with minimal to no difficulty. | Not met | Met |
| Patient will report moderate to minimal difficulty lifting objects from the floor. | Not met | Met |
| Patient will improve strength of right rhomboid, mid trapezius to 4-/5 for lifting objects and maintaining arm positioning for work related activities, and overhead activities. | Partially met | Met |
| Patient will improve right shoulder flexion and abduction, and elbow flexion strength to 4-/5 to improve functional reaching and lifting overhead activities. | Not met | Not met |
| Patient will improve right right shoulder abduction active range of motion to 110 degrees for functional activities like reaching and lifting overhead activities. | Not met | Met |
| Patient will improve right grip and pinch strength equal to left. | Partially met | Partially met |
| Patient will improve QuickDASH to 30% or less. | Not met | Not met |

| | |
|---|---|
| (A) Electrode placement to stimulate biceps for elbow flexion | (B) Electrode placement to stimulate supinator for forearm supination |

**Figure 1.**

NMES Electrode Placement for Elbow Flexion and Forearm Supination. (A) Biceps stimulation for elbow flexion. The negative electrode is placed over the muscle belly below the acromion process. The positive electrode is placed on the muscle belly just proximal to the elbow crease. (B) Supinator stimulation for forearm supination. The negative electrode is placed on the proximal forearm near the lateral epicondyle. The positive electrode is placed near the supinator insertion point on the radius.

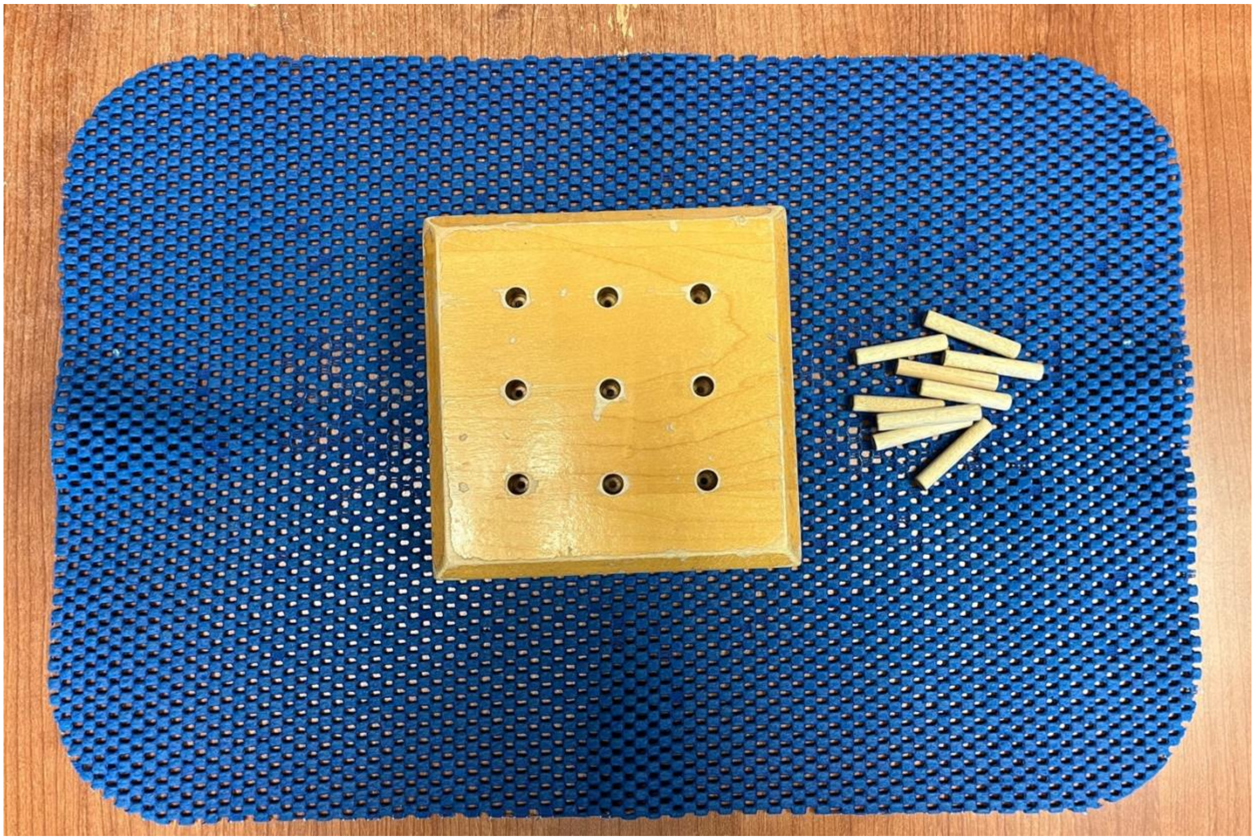

**Figure 2.**

The Nine-Hole Peg Test a standardized assessment tool used to evaluate upper-extremity dexterity and coordination.

**Appendix A.**

Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) [23]

## QUICK DASH

Please rate your ability to do the following activities in the last week by circling the number next to the appropriate response.

| | No Difficulty | Mild Difficulty | Moderate Difficulty | Severe Difficulty | Unable |
|---|---|---|---|---|---|
| 1. Open a tight or new jar. | 1 | 2 | 3 | 4 | 5 |
| 2. Do heavy household chores. (e.g., wash walls, floors) | 1 | 2 | 3 | 4 | 5 |
| 3. Carry a shopping bag or briefcase. | 1 | 2 | 3 | 4 | 5 |
| 4. Wash your back. | 1 | 2 | 3 | 4 | 5 |
| 5. Use a knife to cut food. | 1 | 2 | 3 | 4 | 5 |
| 6. Recreational activities in which you take some force or impact through your arm, shoulder or hand. (e.g., golf, hammering, tennis, etc.) | 1 | 2 | 3 | 4 | 5 |

| | Not at all | Slightly | Moderately | Quite a Bit | Extremely |
|---|---|---|---|---|---|
| 7. During the past week, to what extent has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbors or groups? | 1 | 2 | 3 | 4 | 5 |

| | Not Limited At All | Slightly Limited | Moderately Limited | Very Limited | Unable |
|---|---|---|---|---|---|
| 8. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem? | 1 | 2 | 3 | 4 | 5 |

**Please rate the severity of the symptoms in the last week *(circle number)***

| | None | Mild | Moderate | Severe | Extreme |
|---|---|---|---|---|---|
| 9. Arm, shoulder or hand pain. | 1 | 2 | 3 | 4 | 5 |
| 10. Tingling (pins and needles) in your arm, shoulder or hand. | 1 | 2 | 3 | 4 | 5 |

| | No Difficulty | Mild Difficulty | Moderate Difficulty | Severe Difficulty | So Much Difficulty That I Can't Sleep |
|---|---|---|---|---|---|
| 11. During the past week, how much difficulty have you had sleeping because of pain in your arm, shoulder or hand? *(circle number)* | 1 | 2 | 3 | 4 | 5 |

**QuickDash Disability/Symptom Score** - $\left(\left[\frac{\text{(sum of n responses)}}{n}\right] - 1\right) \times 25$, where n is equal to the number of completed responses.

*A QuickDash score may not be calculated if there is greater than 1 missing item.

## Appendix B.

Neck Disability Index (NDI) [22]

### Neck Disability Index

THIS QUESTIONNAIRE IS DESIGNED TO HELP US BETTER UNDERSTAND HOW YOUR **NECK PAIN** AFFECTS YOUR ABILITY TO MANAGE EVERYDAY -LIFE ACTIVITIES. PLEASE MARK IN EACH SECTION THE **ONE BOX** THAT APPLIES TO YOU.
ALTHOUGH YOU MAY CONSIDER THAT TWO OF THE STATEMENTS IN ANY ONE SECTION RELATE TO YOU, PLEASE MARK THE BOX THAT **MOST CLOSELY** DESCRIBES YOUR PRESENT -DAY SITUATION.

**SECTION 1 - PAIN INTENSITY**

- ❑ I have no neck pain at the moment.
- ❑ The pain is very mild at the moment.
- ❑ The pain is moderate at the moment.
- ❑ The pain is fairly severe at the moment.
- ❑ The pain is very severe at the moment.
- ❑ The pain is the worst imaginable at the moment.

**SECTION 2 - PERSONAL CARE**

- ❑ I can look after myself normally without causing extra neck pain.
- ❑ I can look after myself normally, but it causes extra neck pain.
- ❑ It is painful to look after myself, and I am slow and careful
- ❑ I need some help but manage most of my personal care.
- ❑ I need help every day in most aspects of self -care.
- ❑ I do not get dressed. I wash with difficulty and stay in bed.

**SECTION 3 – LIFTING**

- ❑ I can lift heavy weights without causing extra neck pain.
- ❑ I can lift heavy weights, but it gives me extra neck pain.
- ❑ Neck pain prevents me from lifting heavy weights off the floor but I can manage if items are conveniently positioned, ie. on a table.
- ❑ Neck pain prevents me from lifting heavy weights, but I can manage light weights if they are conveniently positioned
- ❑ I can lift only very light weights.
- ❑ I cannot lift or carry anything at all.

**SECTION 4 – READING**

- ❑ I can read as much as I want with no neck pain.
- ❑ I can read as much as I want with slight neck pain.
- ❑ I can read as much as I want with moderate neck pain.
- ❑ I can't read as much as I want because of moderate neck pain.
- ❑ I can't read as much as I want because of severe neck pain.
- ❑ I can't read at all.

**SECTION 5 – HEADACHES**

- ❑ I have no headaches at all.
- ❑ I have slight headaches that come infrequently.
- ❑ I have moderate headaches that come infrequently.
- ❑ I have moderate headaches that come frequently.
- ❑ I have severe headaches that come frequently.
- ❑ I have headaches almost all the time.

**SECTION 6 – CONCENTRATION**

- ❑ I can concentrate fully without difficulty.
- ❑ I can concentrate fully with slight difficulty.
- ❑ I have a fair degree of difficulty concentrating.
- ❑ I have a lot of difficulty concentrating.
- ❑ I have a great deal of difficulty concentrating.
- ❑ I can't concentrate at all.

**SECTION 7 – WORK**

- ❑ I can do as much work as I want.
- ❑ I can only do my usual work, but no more.
- ❑ I can do most of my usual work, but no more.
- ❑ I can't do my usual work.
- ❑ I can hardly do any work at all.
- ❑ I can't do any work at all.

**SECTION 8 – DRIVING**

- ❑ I can drive my car without neck pain.
- ❑ I can drive my car with only slight neck pain.
- ❑ I can drive as long as I want with moderate neck pain.
- ❑ I can't drive as long as I want because of moderate neck pain.
- ❑ I can hardly drive at all because of severe neck pain.
- ❑ I can't drive my care at all because of neck pain.

**SECTION 9 – SLEEPING**

- ❑ I have no trouble sleeping.
- ❑ My sleep is slightly disturbed for less than 1 hour.
- ❑ My sleep is mildly disturbed for up to 1-2 hours.
- ❑ My sleep is moderately disturbed for up to 2-3 hours.
- ❑ My sleep is greatly disturbed for up to 3-5 hours.
- ❑ My sleep is completely disturbed for up to 5-7 hours.

**SECTION 10 – RECREATION**

- ❑ I am able to engage in all my recreational activities with no neck pain at all.
- ❑ I am able to engage in all my recreational activities with some neck pain.
- ❑ I am able to engage in most, but not all of my recreational activities because of pain in my neck.
- ❑ I am able to engage in a few of my recreational activities because of neck pain.
- ❑ I can hardly do recreational activities due to neck pain.
- ❑ I can't do any recreational activities due to neck pain.

PATIENT NAME ________________________________________ DATE _____________

SCORE __________ [50]