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Physical Therapy and Rehabilitation Science

Fall 2019

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# Physical Therapy Management of Newly Diagnosed Neuromyelitis Optica: A Case Report

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## Abstract

**Background:** Neuromyelitis opticans (NMO) is an immune-mediated inflammatory disorder of the central nervous system, characterized by neuron demyelination that primarily targets the spinal cord and optic nerves. Diagnostic features of NMO include presence of a serum NMO-immunoglobulin G (IgG) antibody that binds to aquaporin-4 (AQP-4) and acute flare-ups of bilateral optic neuritis and myelitis. **Purpose:** Due to limited research about NMO, the purpose of this case report is to describe the clinical decision-making process used to create an inpatient rehabilitation treatment plan for a patient with newly diagnosed neuromyelitis optica. **Case Description:** A 45-year-old African American female presented to the emergency department with progressive weakness of her bilateral lower extremities, which had advanced to a point where she was no longer able to walk or move her legs during her initial hospital stay. Following her diagnosis of NMO, she was transferred to an inpatient rehabilitation department, where she spent the next four weeks working with physical and occupational therapy. **Discussion:** NMO remains a very rare, poorly understood diagnosis with very little evidence to support effective physical therapy interventions. The available research was accessed and utilized in an effective manner, allowing the patient to achieve significant functional gains prior to returning home.

**Keywords:** physical therapy; rehabilitation; neuromyelitis optica; NMO; demyelinating disease; optic neuritis



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**BACKGROUND**

Neuromyelitis optica (NMO), a central nervous disorder that affects the spinal cord and optic nerves, commonly presents with acute incidents of transverse myelitis and optic neuritis with an incomplete resolution of symptoms between attacks.[1] Transverse myelitis is used to describe bilateral sensorimotor and autonomic spinal cord dysfunction and inflammation, which presents on MRI as longitudinal lesions that often extend three or more spinal cord levels (Figure 1), most commonly in the cervical or thoracic regions.[1] The central gray matter of the spinal cord is predominantly affected, causing symptoms including para- or quadriplegia, sensory loss caudal to the level of the lesion, and bowel and bladder dysfunction. Optic neuritis presents as unilateral or bilateral vision loss and eye pain, which can appear on MRI with increased signal intensity in the optic nerves or optic chiasm that can extend over half of the distance from the eye to the optic chiasm or posterior optic nerve to the chiasm.[1]

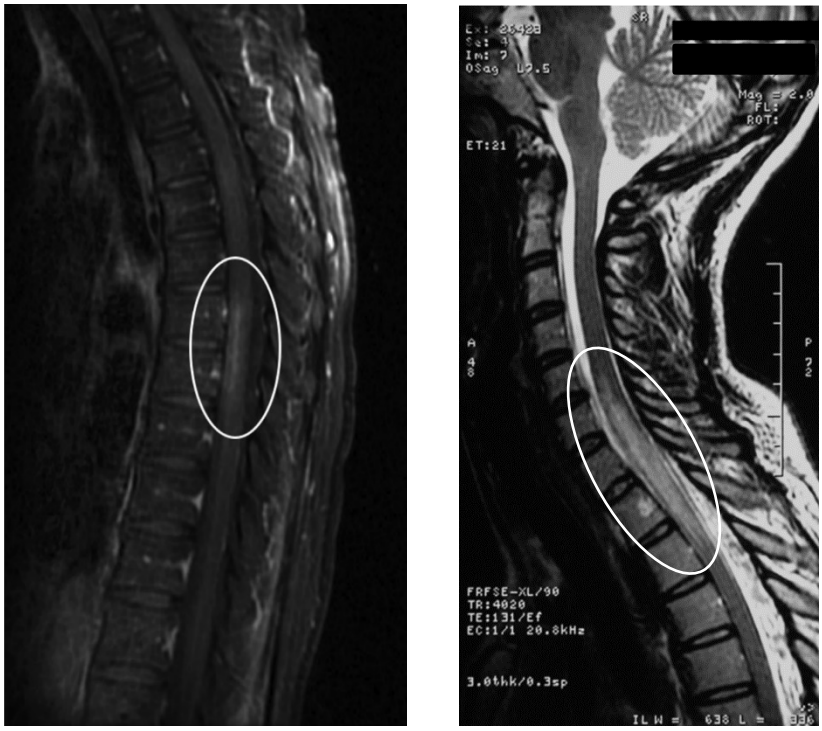


**Figure 1:** *Left:* Abnormal gadolinium enhancement in lower thoracic cord on sagittal T1-weighted sequence.[1]
*Right:* Hypersignal in cervical cord on sagittal T1-weighted sequence.[2]

Aquaporin 4-immunoglobulin G (AQP4-IgG) was recently identified in 2004 as a serum biomarker that has become an important component of the NMO diagnostic process.[3] Before the identification of AQP4-IgG, NMO was thought to be related to multiple sclerosis (MS) due to their seemingly similar symptomatology. Both NMO and MS are demyelinating diseases of the central nervous system, with a non-traumatic neurologic onset and a relapsing-remitting presentation. Though MS is not associated with specific biomarkers, an early differentiating feature of the two diseases is their presentation on MRI imaging. NMO typically spares the brain while predominantly manifesting in and affecting the spinal cord, but can have non-specific and clinically silent brain lesions, while MS presents with progressive periventricular white matter brain lesions that contribute to a patient's functional impairment.[4] In the spinal cord, MS myelitis attacks typically cause asymmetric symptom onset and lesions rarely extend beyond 1-2 vertebral segments, while NMO myelitis attacks often span three or more vertebral segments and have a symmetrical presentation of symptoms.[4]

Since the discovery of AQP4-IgG, research efforts behind the diagnostic process and available treatment options have become much more specific, allowing for improved accuracy and efficiency of diagnosis. Not all patients who are diagnosed with NMO test positive for AQP4-IgG, however, so



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different diagnostic criteria exist based on whether someone is seropositive or seronegative. For those who do test positive for AQP4-IgG and have had all other alternative diagnoses excluded, one must present with at least one of six core characteristics: optic neuritis, acute myelitis, area postremia syndrome, acute brain stem syndrome, symptomatic narcolepsy or acute diencephalic clinical syndrome with NMO-type diencephalic MRI lesions, and symptomatic cerebral syndrome with NMO-typical brain lesions.[3] For those who test negative for AQP4-IgG and have had all other alternative diagnoses excluded, one must present with at least two different core characteristics, with at least one findings including optic neuritis, acute myelitis, longitudinally extensive transverse myelitis, or area postremia syndrome, and have additional MRI findings.[3]

Once diagnosed with NMO, 80-90% of patients have a relapsing-remitting presentation of optic neuritis and transverse myelitis, as opposed to a progressive disease course.[4] On average, 60% of patients experience a relapse within the first year and 90% experience a relapse within the first three years.[4] Especially during periods of relapsing symptoms, major functional limitations can occur that impact all aspects of a patient's life. The SF-36, Expanded Disability Status Scale (EDSS), and FIM scores have all be used as assessments of both general functioning and quality of life. These scores have also been used to assess the efficacy of pharmaceutical and therapeutic interventions to evaluate the functional impact of selected treatments.[5] Fatigue has also been identified as a predictor of quality of life, with increased fatigue correlating with increased incidence of depression, increased pain intensity, worse sleep quality, and overall poorer scores on the physical and mental scores of the SF-36.[6]

Because NMO is both a relatively new diagnostic option for medical professionals and is a rare disease altogether, evidence-based treatment options are still relatively limited. At this time, most of the research about treatment interventions for NMO are related to new and existing pharmaceutical options, and little is known about best practice for physical therapists. Because of the similarities between NMO and MS, early treatment was based on the treatment protocols for MS. The recent discoveries of the differences between the two diseases have made a significant impact on which drugs are selected, as it has been shown that many MS drugs can exacerbate NMO.[2] Acute attacks of NMO are treated with intravenous corticosteroids, typically 1000mg per day for 3-5 days, and a series of plasma exchanges can occur for severe attacks that do not respond to corticosteroids.[3] No prospective trials exist at this time to assess treatments for NMO attacks, thus the optimal dose or duration of acute therapies has not yet been established.[7] Some studies suggest that plasma exchange can be a more effective first line treatment for acute attacks, but additional research is needed to more definitively determine the best course of action.[3] Additional research suggests that concurrent use of corticosteroids and plasma exchange has demonstrated improved visual symptoms, suggesting that delayed neurological improvement could prompt the initiation of plasma exchange for acute attacks.[7]

Due to the limited research pool about NMO in general, non-pharmaceutical research about NMO rehabilitation is extremely limited. Despite this challenge, due to the similarities between NMO and MS, some research suggests that patients with NMO have benefitted from rehabilitation interventions that were originally designed for patients with MS. When comparing how patients with MS and NMO respond to rehabilitation in a multidisciplinary inpatient rehabilitation setting, both groups demonstrate functional improvements per FIM and EDSS scores, with NMO patients having a longer average length of stay but also achieving more significant functional gains.[8] It is possible that patients with MS who access inpatient rehabilitation are further progressed in their disease process due to its slower progression, while patients with NMO may be early in their diagnosis due to its rapid onset. Because of this, patients with NMO typically have a benefit during rehabilitation of more intact cognition and communication abilities, which can aid in the efficacy of the rehabilitation process.[8] Other benefits of inpatient rehabilitation for individuals with neurological diseases include increased independence in self-care and mobility, improved cognition, and decreased declines in health-related quality life six months after an inpatient rehabilitation stay.[9,10] One overarching theme of research about neurological and demyelinating diseases is the importance of goal-oriented, individualized, and multidisciplinary treatment plans for achieving significant functional progress.[8,9,10]



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Another similarity between NMO and MS that has been suggested is the importance of energy conservation and avoiding fatigue. As fatigue has previously been identified as a significant influence on function, mental health, and quality of life for patients with NMO, it can be very important to identify exercise protocols that are designed to be performed at a sufficient level to promote functional gains in patients with NMO, but that are not so strenuous as to fatigue patients to an unsafe or detrimental level. Generally, studies suggest that low to moderate intensity exercise with regular rest periods minimizes the risk of cellular deterioration and is safe for patients with demyelinating diseases, and have shown to improve muscle power, exercise tolerance, and mobility-related activities.[11] High intensity, strenuous exercise on the other hand has shown to reduce the effectiveness of a course of rehabilitation.[11] When prescribed at an appropriate intensity, exercise therapy has shown to have a positive effect on combating fatigue in patients with MS, further affirming the importance of being intentional and patient-specific with exercise prescriptions for this patient population.[12]

Despite having significant findings, the research pool has many limitations. First and foremost, there is an overwhelming lack of research that is specific to patients with NMO that are receiving physical therapy, thus it is difficult to ascertain what interventions may or may not be effective for this patient population. Second, though there is a larger pool of research about patients with MS receiving physical therapy, because of the slowly progressing nature of MS, the participants in these research studies have often been diagnosed many months to many years prior to their participation in the research interventions.[8] Though there are similarities between the general symptomatology of NMO and MS, due to the severity of each acute NMO attack combined with the often incomplete resolution of symptoms, patients with NMO often access intensive therapy very shortly after their first attack, as these can rapidly limit a patient's functional abilities and overall independence. This differs from access sought by patients with MS, as these patients tend to receive inpatient rehabilitation only after their disease has progressed over time and has accumulated to cause residual functional deficits.

The clinical decision-making that underlies the selected treatment interventions for this case study of a patient with neuromyelitis optica was influenced and supported by the aforementioned research studies, while being individualized to the specific patient's functional progress, existing limitations, and goals throughout the course of treatment. Though some of the cited evidence pertained specifically to multiple sclerosis, because of the functional similarities between NMO and MS, it was anticipated that the patient would respond to interventions that demonstrated functional benefits for patients with MS.

## Case Description

A 45-year-old African American female presented to her local hospital's emergency department with a progressive decline in the strength in her lower extremities. By the time she sought medical attention, the weakness had advanced to a point where she was not able to ambulate and had no movement present in her legs. The patient lived with her husband and teenage daughter in a second story apartment with elevator access. Before the onset of her symptoms, the patient reported being very active and independent, exercising regularly with her husband, and being a full-time stay-at-home mother. She had very strong social support from her family and friends, was very active in her church, and participated in social outings with her family regularly.

Initially, she was suspected to have transverse myelitis, but following further testing her doctors gave an official diagnosis of neuromyelitis optica. A five-day course of corticosteroids was initiated, and she was transferred to a different hospital's inpatient rehabilitation department. When the patient was evaluated, she presented with near-flaccid paralysis of her trunk and lower extremities (Table 1), hypersensitivity at the T5 dermatome level, hyporeflexia of her lower extremities, diminished or absent sensation at T5 and below, and loss of

***Table 1:*** *Manual muscle test grades at initial evaluation.*

| Muscle group | MMT grade (R) | MMT grade (L) |
|---|---|---|
| Hip flexion | 1/5 | 0/5 |
| Knee extension | 1/5 | 0/5 |
| Knee flexion | 1/5 | 0/5 |
| Ankle dorsiflexion | 0/5 | 0/5 |
| Great toe extension | 0/5 | 0/5 |
| Ankle plantar flexors | 0/5 | 0/5 |



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bowel and bladder function. Her upper extremities remained fully functional, she was cognitively intact, and had no communicative deficits.

The patient's primary goal of inpatient rehabilitation was to learn to walk again in order to regain her independence and return to her previous lifestyle. Her daughter was about to start high school at the time of the patient's admission, but her able-bodied husband was unemployed and was planning to be available to provide full-time assistance following discharge from the hospital. Initially, the patient and physical therapist hoped to achieve a functional status of at least minimum assist for transfers from a wheelchair level, and modified independence with wheelchair parts management and propulsion. However, during the patient's rehabilitation stay her husband was offered and accepted a full-time day job. This altered the patient's goals as she still wanted to discharge home, but now needed to be at a modified independent level for all transfers in order for her to be both safe and independent during the day.

**Interventions**

A variety of interventions were trialed and implemented regularly during the patient's rehabilitation stay based largely on the available research pertaining to the patient's diagnosis. During the patient's time in inpatient rehabilitation, the patient was involved with physical therapy, occupational therapy, recreation therapy, and speech therapy throughout her rehabilitation stay. Physical and occupational therapy was provided 5-6 days per week, for 1-2 hours per day per discipline. Recreation therapy was provided 2-4 times per week, depending on the activities available at the respective time. Speech therapy was involved early on to provide an initial screen for deficits, but speech therapy was not indicated as the patient was cognitively intact and had no speech or swallowing needs. The following described interventions comprised the patient's physical therapy treatment course, but many skills were utilized and reinforced during occupational therapy. Additionally, with all interventions, frequent rest breaks were provided based on the patient's level of fatigue. Similar to multiple sclerosis exercise interventions, physical therapists were vigilant in promoting exercise at a level that was challenging, but not so strenuous as to cause more harm than good.

*Trunk and Lower Extremity Strengthening*

Because of the patient's significant weakness and lack of active motion of her lower extremities, the first goal of therapy was to promote activation of flaccid muscles while strengthening muscles groups that were available to utilize. Initially, strengthening focused on the hip musculature, knee extensors, and postural trunk muscles, as these muscle groups had very early motor return. Strengthening began with the use of a powder board with or without an exercise skate, depending on the amount of available active motion. The patient was positioned in supine for the patient to perform gravity-eliminated hip abduction and adduction or in sidelying for gravity-eliminated hip flexion and extension, with the active leg propped up on the powder board. All motions began with active assistance from the physical therapist and progressed to active motion as her strength improved. Hip flexion progressed from gravity-eliminated to against gravity, with the patient performing active hip flexion in trunk-supported short sitting. Hip abductor and adductor strengthening was not able to progress to an against gravity position, but the patient was able to progress these muscle groups to being completed through a larger range of motion and on a standard therapy mat without friction-reducing interventions.

Abdominal strengthening began as unsupported sitting on the edge of a therapy mat, with the patient demonstrating significant instability due to the significant weakness of her postural trunk muscles. As the patient mastered static sitting, varied upper extremity and trunk movements were introduced to challenge her center of balance, including reaching in multiple directions outside of her base of support, twisting, and leaning. Larger, more dynamic movements and the addition of hand weights were utilized to further progress these movements. Partial sit-ups were incorporated in the patient's strengthening, with large foam wedges stacked behind the patient to provide an inclined back support. The patient would perform both slow, eccentric lowering to the foam pads, and a partial sit-up



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to return to neutral upright sitting from the wedges. Of note, isolated upper extremity strengthening was performed with occupational therapy.

*Neuromuscular Electrical Stimulation (NMES)*

NMES was another intervention that was implemented in an attempt to promote additional motor return in the patient's lower extremities. In order to assess the patient's response to electrical stimulation, the quadriceps were the first muscle group that was targeted on the patient's fifth day of rehabilitation. For the first trial of NMES, the patient was placed in a semi-reclined long sitting position with a bolster beneath her right knee. An Empi unit was set to a 50Hz NMES program of a biphasic current, with an on:off time of 10:10 seconds for a total of twenty minutes. The patient was unable to feel the stimulation, so the intensity was turned up until a strong muscle contraction was achieved. The patient was instructed to contract her quadriceps muscle over the bolster, performing a short arc quad. Throughout the trial, the patient was unable to maintain a straightened leg when the e-stim off time began, thus the physical therapist aided in slow lowering of the patient's leg between stimulation.

One adjustment was made from the first NMES trial based on the patient's response, in which the off time was adjusted to be 20 seconds in order to avoid muscular fatigue. Following NMES, the patient did demonstrate some short-term carryover of her ability to activate her quadriceps, so this intervention continued to be utilized throughout the first 2 ½ weeks of her rehabilitation stay to promote motor return. Following NMES, either transfer training or active lower extremity strengthening would typically occur in an attempt to utilize the increased knee extensor capacity for functional gains. This intervention was discontinued during her rehabilitation stay due to a sensory return that occurred. During the final use of NMES, the patient was able to feel the electrical stimulation for the first time which, though demonstrating a significant return in sensation in her lower extremities, also prevented the intervention from being effective as hypersensitivity and pain occurred prior to an effective muscle contraction.

NMES to the patient's gluteal muscles was also trialed once but was discontinued because a strong muscle contraction was not able to be achieved. Thus, the decision was made to strengthen the glute muscles and hip extensor group with active strengthening and through transfer training.

*Transfer Training*

Prior to the patient's NMO diagnosis and hospitalization, the patient regularly exercised and performed strength training, which not only made the patient's upper extremities very strong at baseline, but also provided the patient with very good body awareness and mobility-related problem solving. Because of her strong upper extremities, slideboard transfer training was initiated. The patient was instructed in the use of a slideboard on her first day of rehabilitation, and the patient was able to complete the transfer with moderate assist of one to aid with hip clearance and to block her knees throughout the transfer. In addition to repetition of the transfer, hip clearance training was also initiated with the patient in short sitting on a therapy mat. The patient was instructed in the head-hips relationship and the physical therapist instructed the patient in engagement of her glutes and quadriceps. The physical therapist would block the patient's knees and provide verbal cuing throughout to reinforce her technique. As the patient was able to demonstrate good technique and consistent hip clearance, this training progressed to clearing her hips from the therapy mat surface and performing a lateral scoot along the edge of the mat. Technique reinforcement was again completed regarding appropriate hand placement based on the direction of the patient's scoots and ensuring hip clearance throughout her scooting to avoid shearing and skin breakdown.

By the patient's eleventh day of rehabilitation, she was able to complete level slideboard transfers between her wheelchair and the firm therapy mat with minimum assist of one to block the patient's weaker left knee, with the patient demonstrating good transfer technique and consistent hip clearance. At this time, the patient was still dependent for slideboard management due to ongoing lower extremity weakness, requiring the patient to use one upper extremities to support herself as she leaned and the other upper extremity to lift her leg to allow the therapist to position the slideboard. Thus, the patient was instructed in a technique to cross her leg on the side that the slideboard would be placed, lean



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away from the transfer target and support herself on one arm, while utilizing her free second arm to place the slideboard. Within three days, the patient was able to be modified independent with slideboard management for level transfers between firm surfaces. With increased repetitions and practice, the patient progressed to being able to manage the slideboard on compliant surfaces, including her hospital bed. Uphill slideboard transfers were practiced during the patient's third and fourth weeks of rehabilitation, with the patient demonstrating the ability to complete up to an approximately 6" height differential at the conclusion of her rehabilitation.

Based on how well the patient progressed in her slideboard transfer ability, during the patient's final week of rehabilitation, level squat pivot transfer training was initiated to provide the patient an alternate method to transfer from her wheelchair without the use of her slideboard. Following instruction in a squat pivot transfer, the patient completed repetitions between her wheelchair and a level firm therapy mat, requiring only contact guard assist at the conclusion of her first training session. In subsequent therapy sessions, the patient was consistently provided the option to utilize a squat pivot technique or a slideboard to transfer between surfaces, in order to allow the patient to independently gauge her safety and fatigue level as she would be doing following discharge.

*Wheelchair Skills*

Along with the patient progressing with her transfers to and from her wheelchair, the patient was also trained in wheelchair parts management in order to promote independence from a wheelchair level. The patient was using a lightweight manual wheelchair with swing-away arm rests, standard swing-away leg rests, and brakes, and began to be trained on all of the aforementioned parts as soon as transfer training began. She was independent with all parts management by her second week of rehabilitation. When slideboard management training began on the tenth day of rehabilitation, she also began being trained in wheelchair management to set up her transfers, and required only intermittent cuing by the physical therapist to improve the quality of her wheelchair positioning by the middle of the second week of her rehab course. Wheelchair propulsion was used to promote improved cardiorespiratory capacity and upper extremity endurance training. The patient was modified independent with wheelchair propulsion, with her overall speed of propulsion depending on her level of fatigue each day.

*Standing*

An automated standing frame began to be used on the patient's tenth day of her rehabilitation stay for more significant weight-bearing to attempt to promote motor return, strengthen available muscles, and promote maintenance of the patient's lower extremity bone density. The patient demonstrated an inability to fully extend her knees or hips, with significant reliance on the standing frame's harness to maintain her posture. She also demonstrated a significant left lean due to more significant weakness of her left lower extremity. The patient tolerated approximately 10 minutes in the standing frame before reporting fatigue and being returned to her wheelchair. The standing frame was used 2-3 times per week, with the patient demonstrating improved engagement of her hip and knee extensors at each subsequent trial. By her fifth time in the standing frame she was able to maintain midline posture for almost forty minutes, as well as complete mini-squats with the frame harness slightly loosened.

After the patient fifth trial in the standing frame, an UltraMove stand aid began to be utilized due to the patient's significantly improved ability to actively engage her hip and knee extensors to maintain upright posture with the standing frame harness to assist her. The patient was able to use the UltraMove's grab bar to assist her lower extremities in pulling herself to standing. Depending on the patient's fatigue level and the height of the surface she was standing from, she required anywhere from contact guard assist to moderate assist of one to achieve standing. Though the patient tolerated shorter durations of standing – beginning with approximately five to seven minutes and working up to fifteen minutes at a time – the patient reported that she preferred the UltraMove over the standing frame as she felt that she had to work harder to maintain standing and thus no longer wanted to use the standing



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frame. A major focus of the physical therapist's cuing while utilizing UltraMove was maintaining midline posture to facilitate improve left glute engagement.

## Outcomes

Over the patient's three week stay in an inpatient rehabilitation unit, she made significant gains in strength, mobility, and overall functional independence (Table 2). At discharge, the patient was functioning as modified independent from a wheelchair level. She was able to complete uphill and level slideboard transfers and level squat pivot transfers, self-propel and manage all parts of her wheelchair, and perform ADLs as needed to be safe at home throughout the day while her husband worked.

***Table 2:*** *Manual muscle test grades at discharge.*

| Muscle group | MMT grade (R) | MMT grade (L) |
|---|---|---|
| Hip flexion | 2+/5 | 2+/5 |
| Knee extension | 3-/5 | 2+/5 |
| Knee flexion | 2+/5 | 2+/5 |
| Ankle dorsiflexion | 3-/5 | 2+/5 |
| Ankle plantar flexors | 2+/5 | 2+/5 |
| Great toe extension | 2+/5 | 2+/5 |

The Expanded Disability Status Scale (EDSS) and Functional Independence Measure (FIM) were selected as objective measures of patient progress. Currently, there are no outcome measures specific to NMO, so the EDSS was selected because of its utility to evaluate MS.[13] FIM scores were utilized regularly by the inpatient rehabilitation department to monitor patient progress and were thus readily available and tracked routinely.

From the patient's initial evaluation to discharge, her EDSS score improved from 8.5 to 7.0 (Table 3), reflecting an improvement of being essentially bedbound with retained upper extremity use and continued participation her self-cares to being a full-time independent wheelchair user, performing all self-cares and transfers without assistance.[14] Because the EDSS is simply a scale to quantify disability, and not an assessment of progress or function, there is not a minimally clinically important difference for this scale. However, because each successive lower score signifies increased independence and functional mobility, any decrease in an EDSS score is likely significant to the patient's overall functional status. In other available studies, a multidisciplinary inpatient rehabilitation program promoted an average improvement in EDSS scores of about .9, with a discharge level of 6.3 +/- 1.4.[8] The amount of improvement of the patient in this case study was in line with the findings of the study, demonstrating that this patient had a functional level that could be expected following participation in an inpatient rehabilitation program.

***Table 3:*** *EDSS score at initial evaluation and discharge.*

| | Initial Evaluation | Discharge |
|---|---|---|
| **EDSS** | 8.5 | 7.0 |

The patient's transfer- and mobility-related FIM scores improved from being dependent with all transfers and mobility to functioning at a Modified Independent level from a wheelchair (Table 4). For the entire FIM, an improvement of at least 11 points is the minimally clinically important difference, of which the patient greatly exceeded with even the listed categories alone. In other available studies, a multidisciplinary inpatient rehabilitation program promoted an average improvement in FIM scores of about 19.[8] Our patient greatly exceeded the gross improvement in FIM score, but it is unclear if the patient was functioning at a similar level to the patients in the research study.

***Table 4:*** *Mobility-related FIM scores at initial evaluation and discharge.*

| | Initial Evaluation | Discharge |
|---|---|---|
| **Item 9: Bed-to-chair transfer** | 0 | 6 |
| **Item 10: Toilet transfer** | 0 | 6 |
| **Item 11: Tub transfer** | 0 | 6 |
| **Item 12: Walk or wheelchair** | 0 | 6 |
| **Item 13: Stairs** | 0 | 0 |

## Discussion

This case study aimed to describe the clinical decision-making process regarding the interventions that were selected for a patient with a new diagnosis of neuromyelitis optica. Overall, this patient's progress was considered very successful by both the therapists and the patient. Though her ultimate goal of returning to walking was not achieved, her secondary goal of being independent with mobility and ADLs was accomplished. The patient reported at discharge that she still wanted to walk again but



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was satisfied that she was going home independently. The patient had home health physical and occupational therapy set up to begin once she returned home and was looking for an outpatient physical therapy clinic that specialized in neurorehabilitation.

Because of the limited literature surrounding the course of rehabilitation for neuromyelitis optica, it is difficult to determine whether this patient's progress was typical or atypical, but it is important to note that her progress was similar to EDSS outcomes and FIM progress in some available studies that included participants with NMO that had participated in inpatient rehabilitation.[8] Also due to the lack of research specific to physical therapy and neuromyelitis optica, multiple sclerosis exercise principles were utilized to guide treatment selections due to the similarities between the two conditions. Though the patient in this case study had positive outcomes, it is unknown at this time if the interventions were performed in the most effective manner for this specific diagnosis. Though multiple sclerosis has some similar characteristics, it was difficult to truly compare the inpatient rehabilitation experience and outcomes of NMO patients with MS patients because of the differing length of time between diagnosis and inpatient rehabilitation. With MS being a progressive disease that often has a near-complete resolution of symptoms between acute attacks, while NMO often has very severe acute attacks without resolution of symptoms, it is much more common for NMO patients to access inpatient rehabilitation soon after their first attack. For patients with MS, however, inpatient rehabilitation is often not accessed immediately after their diagnosis because of a typically higher functional level compared to a patient's first acute attack of NMO.

Future research about NMO should include evaluating the efficacy of various exercise protocols and rehabilitation interventions in order to better inform physical therapists about the most effective and clinically significant treatment options to improve patient function and independence. Future research should also include retrospective research to better understand how NMO presents in a patient over time in order to have better control populations to compare treatment groups to.

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