

Case Report

Return to Driving In a Patient with Chronic Stroke and Unilateral Neglect Syndrome

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Abstract

Background and Purpose: Unilateral neglect syndrome is a common issue following stroke correlated with poor prognosis for recovery of independent functioning including driving. The purpose of this case report is to describe an episode of physical therapy in which a multi-modal treatment approach was utilized resulting in return to driving for an individual who experienced a right hemispheric ischemic stroke with associated left unilateral neglect syndrome. An overview of the clinical assessments, plan of care, patient and family centered goal setting, intervention strategies, and use of the International Classification of Functioning, Disability and Health to guide patient management, are provided.

Case Description: The patient was a 67-year-old male post ischemic stroke. Although this patient was physically high functioning following the stroke, the presence of unilateral neglect syndrome required him to have assistance with instrumental activities of daily living and precluded him from driving. Driving was the primary goal identified by the patient and his care partners, therefore the physical therapy plan of care was structured around skills required for this task such as motor control, visual attention, sensory awareness, and spatial perception.

Outcomes: The patient demonstrated improvement in visuospatial awareness, reaction time and accuracy, attention, sensory awareness and coordination. Upon re-evaluation, the patient was deemed to be safe to drive with limitations.

Discussion: In a patient with chronic stroke, a multi-modal approach to treating unilateral neglect syndrome achieved the outcome of safe return to driving. Appropriate early identification and documentation of neglect, specialized multidisciplinary assessment and patient and family centered

Background and Purpose

Stroke is the third leading cause of disability worldwide [1] and a leading cause of serious long-term disability in the United States. Following stroke, individuals frequently have residual impairments affecting the ability to independently perform activities of daily living, mobility tasks, and cognitive functions. Many individuals who regain the ability to perform basic daily activities independently may experience difficulty and dependency with meaningful complex tasks, which are either indicative of, or necessary for full life participation, such as driving, returning to work or community leisure activities [2]. Utilization of the International Classification of Functioning, Disability and Health (ICF) as a clinical decision making model, including identification of impairments, resources, activity limitations and participation restrictions within the context of person-environment factors, can be a useful structure for developing more precise, tailored programs that will have a greater likelihood of success than programs based on traditional disablement models [3].

While stroke can lead to a broad variety of deficits, neglect is among the most common and debilitating [4]. The most broadly accepted definition of neglect was put forward by Heilman et al. [5] as follows: "Visuospatial neglect is the failure to report, respond or orient to novel or meaningful stimuli presented to the side opposite a brain lesion." In clinical practice, as well as in the literature, this condition is referred to by a variety of synonymous terms such as unilateral neglect, hemi-inattention, hemispacial neglect, visual neglect and visuospatial neglect. Within this paper, the term 'neglect' or 'unilateral neglect syndrome' will be used. The reported incidence of neglect following stroke ranges greatly and has been estimated to occur in 30-90% of all stroke cases,

and as high as 43% in right hemispheric lesions [6]. The effects of neglect are more severe and long lasting in right hemispheric lesions [4]. Clinically neglect is often under-documented and proves difficult to treat effectively. The literature supports several promising, high tech rehabilitation interventions for neglect, such as transcranial magnetic stimulation, transcranial direct-current stimulation, virtual reality and prism adaptation [7]. However, there is little shown to be practical and consistently effective for the rehabilitation clinician attempting to address neglect in a typical therapy clinic [6].

Driving is a complex and high-risk activity. Stroke has the potential to impact skills necessary for safe driving such as motor function, sensory processing, perceptual and cognitive abilities. The presence of neglect following stroke is thought to be a significant barrier to return to driving [8]. For many individuals, driving is an essential part of active, independent living. The inability to drive has a strong negative correlation with quality of life measures [9]. The literature is growing, but still inadequate, in providing evidence for prognostication of return to driving post stroke [7,10], valid and reliable driving evaluation tools [11] and proven rehabilitation interventions targeting driving skills [12]. The purpose of this paper is to describe multi-disciplinary assessment and use of the ICF to determine a physical therapy intervention to promote return to driving in an individual who experienced a right hemispheric ischemic stroke with associated left unilateral neglect syndrome.

Patient History/Review of Systems

The individual described in this case report was a 67-year-old, right handed male approximately 14 months post multifocal ischemic stroke. The medical diagnosis established during the initial hospitalization was multifocal ischemic infarctions due to cardioembolic shower involving the right middle cerebral and posterior cerebral arteries. Relevant imaging included Transesophageal Echocardiogram (TEE), which did not identify a source for the emboli, and Magnetic Resonance Imaging (MRI), which confirmed the structures affected during the ischemic event included the occipital and parietal lobes, as well as the centrum semiovale in the frontal lobe. Comorbidities included hypertension,

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type II diabetes mellitus, dyslipidemia, coronary artery disease and depression.

He presented to the emergency department and was subsequently admitted to the acute care facility on the same day the infarcts occurred. He was discharged home three days later with specific instructions as follows: “unsafe to drive due to left sided hemi-neglect and a visual field deficit.” No formal testing for neglect was documented in the medical records. Despite the presence of physician orders for multidisciplinary follow up, no therapies were received following hospital discharge. Due to ongoing difficulty with problem solving, memory and mood, the patient was referred for neuropsychological testing seven months after his stroke. Neuropsychological testing confirmed impairments in psychomotor speed, working memory, concentration, problem solving, and visuoperceptual ability. Testing also confirmed that he met the criteria for Major Depressive Disorder. Three months following neuropsychological testing the patient participated in the initial driving evaluation. Chronology of key events is summarized in Figure 1.

emotional and psychological implications for this patient. Return to driving was the primary goal identified by the patient and the caregivers. The caregivers stated that they would also like to see improvements in his ability to recognize his deficits and in functional problem solving. The primary goals established for physical therapy were:

1. To be compliant and independent with a progressive home program addressing deficits associated with unilateral neglect syndrome.
2. Successful completion of the driving re-evaluation to allow for independent participation in community based work and leisure activities.

Examination

Upon initiation of physical therapy, this client had an extensive existing history of assessment related to the primary complaints including: medical work up in the emergency department and acute care, neuropsychological testing and a driving evaluation. Though no formal



Figure 1: Significant chronological events related to physical therapy episode.

The patient was a Hispanic male born in Puerto Rico and raised in New York City. He had a 10th grade education with eventual achievement of a Graduate Equivalency Diploma and technical training for automobile mechanics. He lived at home with his supportive adult daughter and wife of forty-eight years. He worked as a mechanic until two years prior to his stroke at which time he was terminated from his job. This was a significantly stressful psychosocial event. From the time he lost his job until the stroke he was working in an unpaid position as a mechanic in the shop of a relative.

While this patient was physically high functioning following the stroke (independent with basic activities of daily living and household and community ambulation), the presence of neglect required him to have assistance with instrumental activities of daily living and precluded him from driving. He had been active and independent prior to the stroke. Although both his wife and daughter had been consistent care-partners and strong advocates for his recovery and well being since the stroke, the dependence on others following the stroke had negative

assessment for neglect was documented, neglect was first identified and documented as a symptom by an acute care physician within three days of the patient’s initial infarct. Approximately seven months after discharge from the acute care facility, the patient underwent neuropsychological testing which more specifically confirmed and described his cognitive and perceptual deficits (Table 1). The initial driving evaluation occurred over two sessions and was performed by an occupational therapist. It consisted of a series of clinical tests and an on-road driving assessment. Both portions confirmed the presence of neglect as the primary deficit precluding the patient from safely operating a motor vehicle (Table 2).

The physical therapy assessment focused on assessing the severity of neglect and other impairments related to driving skills and ruling out other issues that would impact the patient’s safety. The patient had no focal deficits in strength or range of motion. He did not have deficits in gait speed or postural control. Sensory testing showed normal light touch and proprioception, impaired stereognosis on the left and positive sensory extinction in both upper and lower extremities. Visual

Table 1: Summary of Neuropsychological Tests and Results.

Reason for referral: “Evaluate cognitive and emotional functioning.”	
Tests administered:	
1	Wide Range Achievement Test, 4 th edition reading subtest
2	Boston Naming Test
3	Rey Complex Figure Copy
4	Benton Visual Form Discrimination
5	Clock Drawing Test
6	Trailmaking Test (A and B)
7	Wisconsin Card Sorting Test (WCST-128)
8	Category and Letter Fluencies
9	Rey Auditory Verbal Learning Test (AVLT)
10	Wechsler Memory Scales, 4 th edition (WMS-IV)
11	Logical Memory and Visual Reproduction Subtests
12	D-KEFS Visual Scanning Subtests
13	Wechsler Adult Intelligence Scale, 4 th edition (WAIS-IV): Block Design, Digit Span, Arithmetic, Symbol Search and Coding Subtests
14	Beck Depression Inventory, 2 nd edition (BDI-II)
15	Beck Anxiety Inventory (BAI)
Domains Assessed	Results Summary
Baseline general cognitive functioning	Average
Language abilities	Within normal limits; category fluency-low average
Visuoperceptual abilities	Variable: draw clock face, set time, copy complex designs, select matching figures was average; timed visual scanning tasks and task requiring speeded visuoperception were mildly impaired; errors in both speed and accuracy
Attention	Low average
Working memory and concentration	Mildly impaired
Executive function	Moderately impaired with task switching, connecting letters and numbers in order and novel problem solving
Psychomotor speed	Mildly impaired for connecting numbers in order, scanning for matching shapes and pairing numbers and symbols according to a key
Learning and memory	Mildly impaired/low average for list learning, recognition performance, immediate recall and recognition of story details
Emotionally	Met the criteria for Major Depressive Disorder; clinically significant number of symptoms for depression and anxiety including problems with concentration, sleep, energy, sexual desire, feeling sad, discouraged, irritable, guilty, restless, indecisive and disappointed.

Table 2: Summary of Driving Evaluation Tests and Results.

Presenting Diagnoses: ischemic stroke; vascular dementia; carpal tunnel		
Clinical Tests Administered:		
1	Vision exam (prescreening for acuity, horizontal fields, peripheral vision, saccades, range of motion, depth perception, diplopia)	
2	MVPT (motor free visual perceptual test) version 2 revised	
3	SLUMS mental examination	
4	Short Blessed Cognitive Screen	
5	Optec 2500 Vision Screener	
6	UFOV (useful field of view assessment)	
7	Line Bisection Test	
8	H Cancellation Test	
9	Trails A and B	
10	Grommet in Hand Manipulation Test	
On-road Skills Assessed	Results Summary	
	Initial	Re-evaluation
Speed control (smoothness, stop locations, coordination of gas and break)	Independent	Independent
Steering (Right turns, left turns, lane tracking, lane correction)	Independent	Independent
Secondary controls (ignition, adjust mirrors, turn signals, gearshift, lights, wipers)	Independent, requires modification	Independent
Lane changing (check traffic, blind spot, signal, movement)	In his home area, he lane changed into left lane without checking traffic, without signaling; There was a vehicle in the lane he attempted to change into; he needed the evaluator to tell him not to lane change in order to avoid the car; he did not realize he was changing lanes to his left	Independent
Parking (positions, corrections)	Independent (angle)	Independent
Observations (road marking, signs, traffic controls, awareness of surrounding traffic, safety awareness, judgement, endurance)	He attempted to drive through a red light; required the evaluator to break for him At an unprotected left turn, he almost drove in front of an oncoming car which beeped to alert him He took a right on red into the Facility and did not check for traffic from his left.	Independent

field testing did not confirm a field deficit as was indicated in his earlier medical records. He was able to cross midline during visual scanning testing, but was noted to avoid spontaneous scanning across midline in the absence of specific instructions or stimulus to do so.

Further assessment was performed to quantify the accuracy and timing of motor responses to stimuli presented in random temporal order to the peripheral visual fields. The patient was asked to catch a ball large enough in diameter to require the use of both arms. He was instructed to look at a midline target placed on the wall he was facing, then turn to visualize and catch the ball once it was detected in his peripheral visual field. This activity was performed at 45 degrees to each side of midline. During the initial assessment, the patient was able to successfully catch 15/15 from the right side and 1/15 from the left.

Of added significance, the patient demonstrated decreased awareness of deficits. Frequently during therapy, he attributed his performance deficits to nonneurologic causes. For example, during part of the PT assessment, he stated that he could not catch the ball because his hand was too dry and requested some lotion or a tacky ball to make it easier to catch. He had difficulty recognizing that neglect was present and acknowledging that it negatively impacted his performance and safety.

Clinical Impression

The information gathered by multiple medical disciplines following this patient’s stroke provides clear evidence for a clinical diagnosis of left unilateral neglect syndrome following ischemic stroke. He presented

to physical therapy with a combination of findings typically associated with neglect including diminished awareness of touch and visual stimuli on the left, decreased initiation and coordination of movement in the left upper and lower extremities, as well as cognitive behavioral issues common to neglect syndrome including deficit denial, impaired attention, problem solving and working memory [13].

The International Classification of Functioning model was helpful in guiding development of the plan of care as well as clarifying factors contributing to rehabilitation potential and outcome prognosis for returning to driving. Given the motivation of the patient, outstanding family support, identification of focused and achievable goals and overall level of functioning, it was felt this client could benefit from physical therapy to address specific skills required for return to driving. Depression and deficit denial were identified as potential barriers to progress and attainment of desired outcomes.

Intervention

(Table 3) To address the goal of safe return to driving, initial physical therapy interventions were targeted towards efficient and accurate responses to moving stimuli randomly entering the left visual field. Catch/throw tasks were used for this purpose in clinical and home program exercises. The tasks were designed to 10 require trunk rotation, bimanual activation and visual attention. The challenge was increased by moving the stimuli further into the peripheral fields, as well as increasing the speed and randomization of the introduction of stimuli. Catch/throw tasks were also incorporated to require rapid alternating use of each upper extremity and effective visual scanning in the frontal portion of the visual field.

Over the course of therapy, the patient’s over-reliance on vision for effective use of his left hand became increasingly apparent. Consequently he was assigned a series of tasks to improve sensory awareness and discrimination in his left hand such as coin and shape sorting, blinded nut and bolt assembly and modified Constraint Induced Movement

Therapy (m-CIMT). Constraint Induced Movement Therapy has been shown to be effective in treatment of neglect [14], and the modified constraint induced movement therapy (m-CIMT) program was included in the plan of care beginning in week three. The patient initially demonstrated limited compliance with the m-CIMT program. This dramatically improved following the introduction of a behavioral contract and additional patient and care-partner education regarding the benefits of mCIMT when the appropriate treatment dosage is achieved. From this point forward in the therapy program, the patient consistently documented in a home activity log and provided weekly writing samples. Through his daily logs he was able to demonstrate consistent wearing of the mitt 4-6 hours per day at least 5 days per week.

Although no other deficits were noted in lower extremity motor control, the patient demonstrated significant difficulty with lateral stepping towards the left. When attempting to move and place his left leg, his steps were poorly timed with inconsistent foot placement at initial contact. Gait training for lateral stepping on a treadmill was utilized to promote timing and accuracy of lower extremity responses. The task challenge was progressed by introducing obstacles, increasing the treadmill speed, decreasing upper extremity support and decreasing visual input.

Outcome

The patient participated in eleven, one-hour physical therapy sessions over five months. He also completed 5-7 hours weekly of a home program. Throughout the course of the physical therapy episode, he demonstrated steady improvements and was able to engage in progressively more challenging activities. At the point the decision was made that his progress was sufficient to retake the driving evaluation, he had achieved a level of 100% accuracy on peripheral vision catching bilaterally from the 45 and 90 degree positions with random spatial and temporal challenges; he demonstrated 90% accuracy with stereognosis tasks of shape and coin sorting with the left hand. Sidestepping to the left on the treadmill could be performed with no upper extremity support and no clinically discernable decomposition of movement control or

Table 3: Summary of Physical Therapy Interventions.

Intervention	Duration/dose/setting	Purpose	Evidence
Catch/throw lateral	Clinic: 5-8 minute bouts, 3 bouts per session, 1 session per week; daily home program	Visual awareness; reaction timing; trunk rotation across midline; bimanual UE engagement	Punt, 2006 Vahlberg, 2008
Catch/throw front	Clinic: 5-8 minute bouts, 3 bouts per session, session per week; daily home program	Reactive timing; alternating UE use switching; visual scanning across midline	Vahlberg, 2008
CIMT with behavioral contract	4-8 hours daily during home program and ADL’s	Sensory awareness; left body awareness; high drive functional task training	Punt, 2006 Vahlberg, 2008 Veerbeek, 2014 (16)
Coin and shape sorting; nut/bolt assembly without visual input	Clinic: 5-8 minute bouts, 3 bouts per session, 1 session per week; daily home program	Sensory discrimination and awareness	Vahlberg, 2008
Gait training on treadmill-side stepping left progressing to no UE support	Clinic: 5-8 minute bouts, 3 bouts per session, 1 session per week	Left spatial and body awareness; Motor control; postural control	Vahlberg, 2008 Veerbeek, 2014
Gait training on treadmill-obstacle awareness and negotiation	Clinic: 5-8 minute bouts, 3 bouts per session, 1 session per week	Motor control; postural control; left spatial and body awareness	Veerbeek, 2014

coordination. He was consistently compliant with his home program. Deficit awareness, attention and visual scanning improved as observed in the clinic and per family report, although this was not formally re-assessed.

The driving re-evaluation, performed by the original driving evaluator, concluded that the patient was safe to drive with limitations. He would be restricted to driving within local, familiar areas near his home. One time per month he would be accompanied by a family member for an on road observation to see if any changes had occurred in his driving ability or safety. Ten months following his discharge from physical therapy and subsequent re-evaluation of driving ability, the family members have not reported any regression in his driving skills or safety. The patient drives on a weekly basis and has been able, with the exception of monthly skills and safety checks, to resume independent engagement in community occupational and leisure activities.

Discussion

This case study is an example of a multimodal approach to aggressively address unilateral neglect syndrome to achieve independence in driving skills. Although neglect is frequently a primary barrier to return to driving activities, a multimodal approach targeting a combination of visual, perceptual, sensory and motor impairments may be an effective means to address this common and disabling symptom resulting from stroke. Although much research supports a positive effect of CIMT on amount of upper extremity use and quality of movement, limited evidence exists supporting the impact of this intervention on neglect and no other studies have evaluated CIMT for return to driving [14]. Of benefit would be additional research regarding the effectiveness of CIMT, mCIMT and/or a multimodal approach to treating unilateral neglect syndrome for return to driving.

Many cases of neglect spontaneously resolve within twelve to fourteen weeks of initial infarct [4]. Given the chronicity of the stroke at the time of the physical therapy episode, it is unlikely the patient discussed here experienced spontaneous improvement of the neglect symptoms. Appropriate early identification and documentation of neglect [15], specialized multidisciplinary assessment, patient centered goal setting and a multimodal approach to rehabilitation interventions targeted specifically towards driving skills may have contributed to successful return to driving in this patient.

According to many standardized post stroke measures, this patient would be considered high functioning and deemed to have a successful recovery from stroke. But despite his high physical function status, his participation in daily life was still negatively impacted by the stroke. Patients with mild stroke are assumed to achieve full recovery with little or no intervention. However, many such patients may experience persistent disability and difficulty with complex activities [15]. Driving in particular is a complex task that can have profound implications for independence, self efficacy and quality of life, and loss of independent driving ability has been associated with significant emotional distress [8] in many patients.

The outcomes for this patient were favorable. However, prognostication of the clinical and functional outcomes for this client was challenging due to lack of appropriate evaluation tools. Across rehabilitation disciplines, therapists need better clinical tools for gauging potential driving ability after stroke and increased use and documentation of standardized assessment of neglect syndrome in order to develop the most efficacious plan of care to improve return to driving skills.

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