7-2013

Predictors of return to driving after stroke

Elyse L. Aufman
Washington University School of Medicine in St. Louis

Marghuretta D. Bland
Washington University School of Medicine in St. Louis

Peggy P. Barco
Washington University School of Medicine in St. Louis

David B. Carr
Washington University School of Medicine in St. Louis

Catherine E. Lang
Washington University School of Medicine in St. Louis

Predictors of Return to Driving After Stroke

Authors:

Elyse L. Aufman, MOT, OTR/L[1], Marghuretta D. Bland, PT, DPT, NCS, MSCI[2,3], Peggy P. Barco[4], MS, OTR/L, David B. Carr, MD[3,5,6], Catherine E. Lang, PT, PhD[2,3,4]

Affiliations:

[1]Washington University School of Medicine, [2]Washington University Program in Physical Therapy, [3]Washington University Department of Neurology, [4]Washington University Program in Occupational Therapy, [5]Washington University Department of Internal Medicine, [6]The Rehabilitation Institute of Saint Louis, Saint Louis, MO

Correspondence:

Elyse Aufman

Washington University in St. Louis, 4444 Forest Park, Campus Box 8502, Saint Louis, MO 63108

314-633-8450, aufmane@wusm.wustl.edu

Disclosures: Financial disclosure statements have been obtained, and no conflicts of interest have been reported by the authors or by any individuals in control of the content of this article.

Funding for the Brain Recovery Core system setup and maintenance was provided by HealthSouth Corporation, the Washington University McDonnell Center for Systems Neuroscience, and the Foundation for Barnes-Jewish Hospital. Salary support for ELA was provided by the American Academy of Neurology and the Washington University Institute of Clinical and Translational Sciences grants UL1 TR000448 and TL1 TR000449 from the NIH National Center for Advancing Translational Sciences. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH. DBC is supported in part by the Missouri Department of Transportation, Division of Highway Safety, the Washington University Alzheimer's Disease Research Center (P50AG05681, Morris PI), and the program project, Healthy Aging and Senile Dementia (P01AG03991, Morris PI). Dr. Carr is on the speaker's bureau for the Alzheimer's Association, and has been an older driver consultant for the AMA and ADEPT and has support through Pfizer.

Predictors of Return to Driving After Stroke

ABSTRACT

Objective: While returning to driving is a major concern for many stroke survivors, predicting who will return to driving after a stroke is often difficult for rehabilitation professionals. The primary aim of this study was to identify patient factors present at admission to an inpatient rehabilitation hospital that can be used to identify which patients with acute stroke will and will not return to driving.

Design: After comparing returners and non-returners on demographic and clinical characteristics, a logistic regression model with return to driving as the outcome variable was built using the backward stepwise method.

Results: Thirty-one percent (48/156) of patients who had been driving before their stroke had returned to driving six months post-stroke. The final regression model, using FIM cognition and lower extremity Motricity Index scores, predicted the driving outcome with an accuracy of 75% (107/143).

Conclusions: Patients with lower FIM cognition and lower extremity Motricity Index scores at admission to inpatient rehabilitation are less likely to return to driving at six months. This model could be used by rehabilitation professionals to help counsel patients and their families and focus treatment goals.

Key Words: Stroke, Automobile Driving, Rehabilitation, Activities of Daily Living

INTRODUCTION

Returning to driving is a major concern for many stroke survivors and their families[1]. It is not only indispensible for traveling to work, completing everyday tasks like grocery shopping and going to doctors' appointments[2], but it is often seen as a symbol of independence and freedom. Driving is, however, an extremely complicated task that requires many functional abilities that may be affected by a stroke[3]. These functional abilities generally fall under three domains: motor (e.g. turning the wheel, using the foot pedals, turning on windshield wipers), visual-perceptual (e.g. recognizing traffic signs, noticing events in the periphery, parking between lines), and cognitive (e.g. being aware of speed limit, knowing the directions to the destination, planning and assessing safety in merging and switching lanes)[4].

Studies have found that 30-66% of patients return to driving after a stroke[1,2,5-7]. Non-returners are generally more disabled than returners based on total Functional Independence Measure (FIM) scores[2], Barthel Index scores, and arm function tests[1]. The majority of those who do not return to driving report not returning due to physical or mental disabilities, while a smaller percentage report not wanting to return or not being able to afford to return[1]. Non-returners are more likely to be depressed and less likely to do daily activities outside of the home, such as shopping[1,8].

Trying to ascertain which patients will return to driving is a difficult endeavor. Knowing what characteristics may predict returning or not returning is important for physicians, social workers, and rehabilitation professionals involved in the care of stroke survivors. While fitness to drive and its predictors have been reasonably well addressed in stroke literature[9], actual return to driving is a largely unexplored topic, with only two studies cited in the literature[5,6]. Pre-stroke driving frequency, post-stroke Barthel Index, and marital status were found to be predictive of return to driving at six months post-stroke in people with ischemic stroke in one study[5]. In the other, Stroke Impact Scale and Mini-Mental State Examination scores measured at three months post-stroke and stroke type predicted returning to driving at one year[6]. Both of these reports used samples from acute hospital settings, thereby including patients with a wide range of stroke severity and functional deficits.

While examining the predictors of return to driving in all acute stroke patients is useful, it is equally important to examine a certain subset of those patients – those who receive inpatient rehabilitation services after their acute care hospitalization. Persons who receive inpatient rehabilitation typically have impairments in multiple domains, complex rehabilitation needs, and potential for substantial improvements in function. Since physicians and therapists in this setting routinely counsel patients on when and how they can return to driving, the ability to identify returners versus non-returners at time of admission to the unit has high clinical utility. The primary aim of this study, therefore, was to identify patient factors at admission to an inpatient rehabilitation facility (IRF) that can be used to predict which patients with stroke will and will not return to driving.

METHODS

This retrospective cohort study used data collected by the Brain Recovery Core, which is a partnership between Washington University School of Medicine; Barnes-Jewish Hospital, a large, academic, acute care hospital; and the Rehabilitation Institute of St. Louis, a free-standing IRF[10]. The Brain Recovery Core collects demographic and clinical data from participants who have a primary diagnosis of stroke from the acute stroke service and any rehabilitation services they may receive within the system[11]. Participants are then contacted at six and twelve months post-stroke to complete a follow-up survey. All participants have provided informed consent to have their rehabilitation data stored and used for research purposes. The Washington University Human Research Protection Office has approved studies using de-identified data from the Brain Recovery Core database. For this study, only data for participants who had received inpatient rehabilitation services at the IRF were used.

Independent Variables

Independent variables were selected from the database with regards to previous literature, data availability, and clinical judgment. These variables included demographics[5]; stroke hemisphere and type[6]; National Institutes of Health Stroke Scale[12] (NIHSS); Short Blessed Test[13]; Motricity Index for the affected lower extremely (LE) and affected upper extremity[14] (UE); Action Research Arm Test[15] (ARAT) for the affected side; Berg Balance Scale[16] (Berg); Mesulam Cancellation Test[17]; Catherine Bergego Scale – clinician portion[18] (CBS); Woodcock-Johnson (W-J) Numbers Reversed, Spatial Relations, and Retrieval Fluency Tests[19]; Boston Naming Test – 15 Item Short Form[20] (BNT); FIM cognitive score; and FIM walking and upper extremity dressing items[21]. The FIM cognitive score is a composite of the comprehension, expression, social interaction, problem solving, and memory items. The clinical measures represent a range of impairments and activity limitations seen after stroke, including motor (Motricity Index, ARAT, Berg), attention (Mesulam, CBS), cognition (Short Blessed, Woodcock-Johnson tests, FIM cognitive), language (BNT), and function (FIM items). All clinical measures were collected during initial evaluation at the IRF except the NIHSS and the Short Blessed test, which were collected during the acute care stay.

Dependent Variable

Brain Recovery Core participants are contacted by telephone at six months post-stroke to complete a follow-up survey that includes questions about their health, function, mood, and community reintegration. This survey can be completed by the participant or a proxy. The survey question of interest for this study was, “Have you returned to driving?” The participant or proxy could answer, “yes,” “no,” and “not driving prior to stroke.” Answers to this question were used as the dependent variable in the logistic regression analyses.

Statistical Analysis

Data were analyzed using SPSS Statistics version 19.0. Due to the real world, clinical nature of data collection for the Brain Recovery Core, data were missing from many of the clinical variables. The NIHSS and Short Blessed Test were collected in all patients who were admitted to the IRF from Barnes-Jewish Hospital, but were unable to be obtained from those patients who came in through an outside hospital. For the other clinical variables with more than 10% missing data (including Motricity UE, ARAT, Mesulam, CBS, W-J Numbers Reversed, W-J Spatial Relations, W-J Retrieval Fluency, and BNT), we probed if the missing data were random. Variables were dichotomized into cases with observed values and those with missing values. The two groups were then compared on the variables with less than 10% missing data (including age, Motricity LE, Berg, FIM scores) and the NIHSS using Mann-Whitney *U* tests[22]. No significant (p<.05) differences were found between the observed value versus missing value groups beyond what would be expected by chance (3 of 64 tests), suggesting that the data were missing mostly at random.

Participants were separated into three groups: those who returned to driving (returners), those who had not returned to driving (non-returners), and those who were not driving before their stroke (non-drivers). Descriptive statistics were generated for all variables across each group. Variables were then compared across the two groups of interest – returners and non-returners – using the appropriate statistical hypothesis test (independent samples t-test, Mann-Whitney *U* test, or chi-squared test) to search for significant differences that may be predictive of return to driving. Criterion for significance was set at 0.05 for each test. Relationships between clinical variables were also investigated using Pearson product-moment correlation coefficients in order to prevent redundancy in the regression model.

Candidate variables to be placed in the logistic regression model were then selected from all of the variables (listed above) using the results of the hypothesis and correlation tests, previous research, and data availability. The coefficient, odds ratio, and *P*-value for each candidate variable when independently entered into the model were recorded to explore the influence of each variable on return to driving.

A binary logistic regression analysis was then run with the candidate variables using the backward stepwise method. Because this study sought to produce a simple and clinically useful prediction model, each variable left in from the backward method was removed one-by-one to determine the effect the removal had on the predictive power of the model, and variables that contributed little to the predictive power were removed. The final model was validated using the bootstrapping method with 1000 samples[23].

RESULTS

A total of 198 patients with a primary diagnosis of ischemic or hemorrhagic stroke received inpatient rehabilitation services at the IRF and completed the six-month follow-up survey between June 2010 and June 2012. This subset of patients who received inpatient rehabilitation services represents approximately 30% of all stroke admissions at Barnes-Jewish Hospital, with about 50% going home with or without rehabilitation services, 10% to a skilled nursing facility, and the remaining 10% to another facility or deceased. The mean age of this cohort at time of stroke was 61 ± 13 years and 54% (106) were male. African Americans made up 58% (114) of the sample and Caucasians made up 41% (81), which is representative of the population of St. Louis City. Of these 198 participants, 21% (42) were not driving prior to their stroke. Of the 156 who were drivers, 31% (48) had returned to driving at six months post-stroke. The demographic and clinical characteristics of each group are displayed in Table 1.

The last column of Table 1 indicates whether there was a statistically significant difference (as marked by *P*-values) between the returners and the non-returners for each variable. Very few of the demographic variables were significantly different – only marital status, education level, and stroke type – while the majority of the clinical variables measured at the acute care hospital or at admission to the IRF were significantly different. Pearson correlation coefficients among the clinical variables showed strong, significant correlations (> 0.75) between three motor measures (Motricity UE and LE and ARAT). From these three measures, Motricity LE was chosen as the representative variable for the regression model because it had the least amount of missing data (7%). Marital status (single, married), stroke type (ischemic, hemorrhagic), and FIM scores (cognition, walking, UE dressing) were chosen for the regression model based on previous research[5,6], significant group differences, and data availability. Education, NIHSS, and Berg were chosen based on significant group differences and data availability. Although CBS could have been a strong predictor, it was not chosen to be used in the regression model due to its high proportion of missing values.

The candidate variables were then entered into the model one at a time. Table 2 displays the regression coefficients and odds ratios for each individual model. All of the predictors except stroke type were significant. After completing the backward stepwise logistic regression analysis using a removal probability of .10; marital status, NIHSS, Motricity LE, and FIM cognition were left. A series of regression models were produced that removed variables that contributed little to the predictive power; this progression can be seen in Table 3. Marital status and NIHSS were removed from the final model and bootstrapping statistics were performed. The final model uses the FIM cognition and Motricity Index LE and, due to missing values for certain cases, is based on 143 participants. The R^2 of the model was 0.302 ($p < 0.001$) and it correctly identified 48% (22/46) of returners and 88% (85/97) of non-returners. Overall, 75% (107/143) of participants were correctly identified. The positive predictive value of the model was 65% (22/34) and the negative predictive value was 78% (85/109). The area under the ROC curve using this model is .789 (95% CI .713-.866, $p<.001$). Validation by bootstrapping with 1000 samples confirmed the model with significant ($p<.05$) odds ratios (FIM cognition 1.07-1.27, Motricity LE 1.01-1.06).

DISCUSSION

This study of patients with acute stroke who received inpatient rehabilitation services revealed 31% returned to driving at six months post-stroke. This percentage is consistent with some studies that have looked at return to driving after stroke[1,2,5-7], but is lower than the studies that have examined all stroke patients who received acute care but not necessarily inpatient rehabilitation. The lower rate of return is reasonable given that patients who receive inpatient rehabilitation services will likely have had more severe strokes than those who received acute care only, thus leading to fewer returning to driving. Further support for severity of stroke as a possible explanation is indicated by a higher average NIHSS score for this cohort (9.1 points) compared to a previous study[5] (3.5 points, 73% return rate at six months). Although not in the final model, higher NIHSS scores were associated with a lower probability of return to driving (odds ratio = 0.81, Table 2).

When looking at the clinical measures taken during the acute care stay and at admission to the IRF, the current model demonstrates that motor and cognitive deficits are predictors of return to driving. Lower FIM cognition and Motricity Index LE scores as measured at admission to the IRF indicate a lower likelihood of returning to driving. For this model, the Motricity Index LE was chosen to represent motor deficits. As it was strongly correlated with the Motricity Index UE and the ARAT, it is possible that these other scores may have provided equivalent predictive value if less data had been missing. Being as the FIM is routinely collected at many IRFs around the United States and the lower extremity Motricity Index is a simple test involving manual muscle testing at three core muscle groups in the lower limb (ankle dorsiflexion, knee extension, and hip flexion), this model could be fairly easily applied to patients with stroke at other rehabilitation facilities. Using this predictive model could assist clinicians in counseling patients about their likelihood of return to driving, focusing therapy services, and may impact therapy goals. In addition, the Motricity LE and FIM scores could be measured longitudinally after driver retraining to determine if improvement in these tests were associated with a return to driving.

This study was focused only on whether participants *returned* to driving; it did not address the issue of whether or not participants are *safe* to return to driving. Predictors of fitness to drive after stroke have been reasonably well addressed in the literature[9], but actual return to driving has been largely overlooked. While it is extremely important to know if a person is safe to drive, also being aware of those who are likely to attempt driving is critical. This second issue is particularly important given that a large percentage of stroke survivors are not given driving evaluations or advice about returning to driving[2].

A central issue demonstrated by this and other studies on predictors of return to driving after stroke is the large amount of unexplained variance in the models used. This study's model explained 30% of the variance (46% with all candidate variables included, Table 3), while others have explained 39%[5] and 38%[6]. Other demographic or clinical characteristics could contribute to the unexplained variance, but there are obviously additional important factors not examined in this or other studies. There may be personal factors (e.g. the presence of a family member that can drive), societal factors (e.g. the need to return to work), or financial factors (e.g. being able to afford a car after an acute medical illness) that could impact a return to driving. Awareness of deficits could also affect a person's decision to return to driving, with those who have less awareness being more likely to return despite perhaps not being safe to do so and those with more awareness believing they are not safe to drive. Another possible barrier is car modifications, which allow people with motor deficits to drive. Unfortunately, they may be unknown by patients or their families, too expensive to afford, or too cumbersome to learn in the presence of older age or cognitive deficits. Future research should attempt to elucidate these additional factors in order to work towards enabling more patients with stroke to return to driving.

This study had a number of limitations. The cohort, while representative of St. Louis City, was overall younger and more urban than many stroke cohorts. Thus, there needs to be caution in generalizing these finding to other settings. In addition, data were missing on some of the clinical measures. Because the Brain Recovery Core database uses clinical measures collected by staff therapists during evaluation sessions, missing data are expected. Although statistical tests were completed to check for randomness of missing data, it cannot be guaranteed that data were missing randomly. The missing data limited the number of cases that could be used to run the regression model, so variables without large amounts of missing data were used preferentially. The sample size is fairly small and the model will need to be confirmed in a larger, independent data set. While the specificity and negative predictive value of the final model were strong, the sensitivity and positive predictive value were lower, indicating that this model is better at identifying those who will not return to driving as opposed to those who will. This should be taken into consideration when used in the clinical setting: although patients with low Motricity LE and FIM cognition will likely not return to driving, higher scores do not necessarily predict that they will return. Other factors, such as those mentioned above, need to be considered when counseling patients on returning to driving.

CONCLUSION

Compared to previous studies in the acute care setting, persons with stroke who received inpatient rehabilitation services had a lower rate of return to driving at six months. Motor and cognitive deficits were negative predictors of return to driving at six months post stroke in patients who receive inpatient rehabilitation services. Using FIM cognition and lower extremity Motricity Index scores, clinicians may be able to screen for patients who will not return to driving at an early time point in patients' IRF stay.

This model may allow healthcare professionals to better counsel persons with stroke and their families concerning the likelihood and expectations of returning to driving and focus treatment efforts on the areas that may be critical for a safe return to driving.

ACKNOWLEDGEMENTS

We thank the members of the Brain Recovery Core team from Washington University, Barnes-Jewish Hospital, and the Rehabilitation Institute of Saint Louis for the efforts in developing, implementing and sustaining the project. We also thank the staff and students conducting the follow-up phone calls.

TABLES

Table 1. Group characteristics for non-drivers, non-returners, and returners.

Demographics	**Missing Data**	**Non-Drivers (n=42)**	**Non-Returners (n=108)**	**Returners (n=48)**	***P*[a]**
Age, years	0 (0%)	64.1±14.0	59.9±13.0	61.5±13.7	.468
Gender	0 (0%)				.170
Male		18 (43%)	57 (53%)	31 (65%)	
Race	0 (0%)				.350
African American		29 (69%)	61 (57%)	24 (50%)	
Caucasian		13 (31%)	44 (41%)	24 (50%)	
Marital status	2 (1%)				.026*
Married		9 (23%)	48 (45%)	31 (65%)	
Education, years	5 (3%)	11.3±12.0	12.3±2.4	13.4±3.0	.041*
Prior level of function	11 (7%)				.324
Independent		28 (72%)	95 (95%)	45 (100%)	
Working prior to stroke	0 (0%)				.309
Yes		6 (14%)	38 (35%)	21 (44%)	
First stroke	0 (0%)				.136
Yes		30 (73%)	78 (72%)	40 (83%)	
Stroke hemisphere	49 (31%)				.329
Right		18 (58%)	37 (51%)	12 (35%)	
Left		12 (39%)	32 (44%)	20 (59%)	
Bilateral		1 (3%)	4 (6%)	2 (6%)	
Stroke type	34 (28%)				.044*
Ischemic		31 (91%)	66 (82%)	27 (66%)	
Clinical Assessment Scores[b]					
NIH Stroke Scale (0-42)	34 (28%)	8.4±5.6	11.2±7.6	5.4±3.3	<.001*
Short Blessed (0-33)	72 (46%)	8.9±6.1	7.9±6.3	5.6±4.9	.088
Motricity LE (0-100)	11 (7%)	63.1±18.9	53.5±29.3	74.3±21.9	<.001*
Motricity UE (0-100)	61 (39%)	53.2±33.3	46.6±35.8	78.7±21.1	<.001*
ARAT (0-57)	71 (46%)	24.2±22.4	20.6±22.4	38.5±18.6	.001*
Berg (0-56)	12 (8%)	14.8±13.5	13.0±14.8	23.2±15.8	<.001*
Mesulam (sum of all missed)	75 (48%)	17.6±20.1	15.2±17.5	7.6±12.7	.067
CBS (0-30)	79 (51%)	2.5±2.3	4.9±6.6	1.2±2.1	.006*
W-J Numbers (0-100)	73 (47%)	69.4±29.3	72.9±19.5	80.7±16.4	.070
W-J Spatial (0-100)	74 (47%)	83.0±27.7	81.6±26.0	86.3±23.1	.216
W-J Retrieval (0-100)	68 (44%)	60.6±28.8	56.8±27.8	71.1±15.7	.042*
Boston Naming Test (0-15)	56 (36%)	11.0±3.9	10.9±3.4	11.7±3.9	.089
FIM Cognition (5-35)	2 (1%)	19.8±6.7	17.4±6.7	22.8±4.9	<.001*
FIM Walking (1-7)	0 (0%)	1.9±1.2	1.7±1.1	2.4±1.3	<.001*
FIM UE Dressing (1-7)	0 (0%)	3.1±1.4	2.9±1.4	4.0±1.2	<.001*

Data are expressed as mean ± SD or frequencies.

[a]Returners and non-returners were compared on each variable with significance set at .05.

[b]For Clinical Assessment scores, higher scores generally indicate less severity/better abilities. The exceptions to this, where higher scores indicate increased severity, are the NIHSS, the Short Blessed test, the Mesulam, and the CBS.

LE, lower extremity; UE, upper extremity; ARAT, Action Research Arm Test; Berg, Berg Balance Scale; CBS, Catherine Bergego Scale; W-J, Woodcock-Johnson; FIM, Functional Independence Measure.

Table 2. Odds ratios and significance levels for candidate predictors.

	B (SE)	Odds Ratio (95% CI)	*P*[a]
Marital Status	.79 (.36)	2.20 (1.09–4.46)	.028
Stroke Type	.83 (.44)	2.28 (.97–5.36)	.059
NIH Stroke Scale (0-42)	-.21 (.05)	.81 (.73–.90)	<.001
Motricity LE (0-100)	.03 (.01)	1.03 (1.02–1.05)	<.001
Berg (0-56)	.04 (.01)	1.04 (1.02–1.07)	<.001
FIM Cognition (5-35)	.16 (.04)	1.17 (1.09–1.26)	<.001
FIM Walking (0-7)	.49 (.14)	1.62 (1.23–2.15)	.001
FIM UE Dressing (0-7)	.57 (.14)	1.77 (1.34–2.34)	<.001

[a]Significance set at .05.
LE, lower extremity; Berg, Berg Balance Scale; FIM, Functional Independence Measure; UE, upper extremity.

Table 3. Series of logistic regression models from most inclusive to final selected model.

	Odds Ratio (95% CI)			
	Model 1 (n=106)[a]	**Model 2 (n=112)**[b]	**Model 3 (n=141)**	**Model 4 (n=143)**[c]
FIM Cognition (5-35)	1.10 (1.00-1.21)	1.12 (1.03-1.23)	1.16 (1.08-1.26)	1.15 (1.07-1.25)
Motricity LE (0-100)	1.02 (.99-1.05)	1.01 (1.00-1.04)	1.03 (1.01-1.05)	1.03 (1.01-1.05)
Marital Status	2.99 (1.07-8.34)	2.84 (1.06-7.58)	2.12 (.92-4.87)	
NIH Stroke Scale (0-42)	.86 (.74-.99)	.85 (.75-.98)		
Berg (0-56)	.99 (.94-1.04)			
Stroke Type	1.82 (.54-6.07)			
FIM Walking (1-7)	.75 (.46-1.23)			
FIM UE Dressing (1-7)	1.50 (.89-2.51)			
R^2 (Nagelkerke)	.462	.422	.333	.302
AUC	.853 (.782-.924)	.838 (.763-.913)	.801 (.727-.876)	.789 (.713-.866)
Accuracy	75.5%	78.6%	76.6%	74.8%
Sensitivity	63.2%	62.5%	54.3%	47.8%
Specificity	82.4%	87.5%	87.4%	87.6%

[a]Model with all candidate variables entered.
[b]Model after performing backward stepwise regression.
[c]Final selected model.
FIM, Functional Independence Measure; LE, lower extremity; Berg, Berg Balance Scale; UE, upper extremity; AUC, area under the receiver operating characteristic curve.

REFERENCES

1. Legh-Smith J, Wade DT, Hewer RL: Diving after a stroke. *J R Soc Med* 1986;79(4):200-3.

2. Fisk GD, Owsley C, Pulley LV: Driving after stroke: Driving exposure, advice, and evaluations. *Arch Phys Med Rehabil* 1997;78(12):1338-45.

3. Wilson T, Smith T: Driving after stroke. *Int Rehabil Med* 1983;5(4):170-7.

4. Pierce SL: Restoring mobility. In: Radomski MV, Trombly Latham CA, eds. *Occupational Therapy for Physical Dysfunction*. 6th ed. Baltimore, MD: Lippincott Williams & Wilkins; 2008:817-53.

5. Lee N, Tracy J, Bohannon RW, Ahlquist M: Driving resumption and its predictors after stroke. *Conn Med* 2003;67:387-91.

6. Perrier M-J, Korner-Bitensky N, Mayo NE: Patient factors associated with return to driving poststroke: Findings from a multicenter cohort study. *Arch Phys Med Rehabil* 2010;91:868-73.

7. Finestone HM, Marshall SC, Rozenberg D, Moussa RC, Hunt L, Greene-Finestone LS: Differences between poststroke drivers and nondrivers: Demographic characteristics, medical status, and transportation use. *Am J Phys Med Rehabil* 2009;88(11):904-23.

8. Windsor TD, Anstey KJ, Butterworth P, Luszcz MA, Andrews GR: The role of perceived control in explaining depressive symptoms associated with driving cessation in a longitudinal study. *Gerontologist* 2007;47(2):215-23.

9. Devos H, Akinwuntan AE, Nieuwboer A, Truijen S, Tant M, De Weerdt W: Screening for fitness to drive after stroke: A systematic review and meta-analysis. *Neurology* 2011;76(8):747-56.

10. Lang CE, Bland MD, Connor LT, et al: The brain recovery core: Building a system of organized stroke rehabilitation and outcomes assessment across the continuum of care. *J Neurol Phys Ther*. 2011;35:194-201.

11. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG: Research electronic data capture (redcap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42:377-81.

12. Goldstein LB, Samsa GP: Reliability of the National Institutes of Health Stroke Scale: Extension to nonneurologists in the context of a clinical trial. *Stroke* 1997;27:307-10.

13. Katzman R, Brown T, Fuld P, Peck A, Schechter R, Schimmel H: Validation of a short orientation-memory-concentration test of cognitive impairment. *Am J Psychiatry* 1983;140:734-9.

14. Collin C, Wade D: Assessing motor impairment after stroke: A pilot reliability study. *J Neurol Neurosurg Psychiatry* 1990;53:576-9.

15. Lang CE, Wagner JM, Dromerick AW, Edwards DF: Measurement of upper-extremity function early after stroke: Properties of the Action Research Arm Test. *Arch Phys Med Rehabil* 2006;87:1605-10.

16. Berg K, Wood-Dauphinee S, Williams JI: The Balance Scale: Reliability assessment with elderly residents and patients with an acute stroke. *Scand J Rehabil Med* 1995;27:27-36.

17. Rengachary J, d'Avossa G, Sapir A, Shulman GL, Corbetta M. Is the Posner Reaction Time Test more accurate than clinical tests in detecting left neglect in acute and chronic stroke. *Arch Phys Med Rehabil* 2009;90:2081-8.

18. Azouvi P, Olivier S, de Montety G, et al. Behavioral assessment of unilateral neglect: Study of the psychometric properties of the Catherine Bergego Scale. *Arch Phys Med Rehabil* 2003;84:51-7.

19. Woodcock RW, McGrew KS, Mather N: *Woodcock-Johnson III Tests of Cognitive Abilities.* Rolling Meadows, IL: Riverside Publishing Co., 2001.

20. Calero MD, Arnedo ML, Navarro E, Ruiz-Pedrosa M, Carnero C: Usefulness of a 15-item version of the Boston Naming Test in neuropsychological assessment of low-educational elders with dementia. *J Gerontol B Psychol Sci Soc Sci* 2002;57B(2):P187-91.

21. Linacre JM, Heinemann AW, Wright BD, Granger CV, Hamilton BB: The structure and stability of the Functional Independence Measure. *Arch Phys Med Rehabil* 1994;75(2):127-32.

22. Little RJA: A test of missing completely at random for multivariate data with missing values. *J Amer Statist Assoc* 1988;83:1198-202.

23. Steyerberg EW, Harrell FE, Borsboom GJJ: Internal validation of predictive models: Efficiency of some procedures for logistic regression analysis. *J Clin Epidemiol* 2001;54(8):774-81.