Predicting Length of Stay, Functional Outcome, and Aftercare in the Rehabilitation of Stroke Patients

The Dominant Role of Higher-Order Cognition

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Background and Purpose: Research in recent years has revealed factors that are important predictors of physical and functional rehabilitation: demographic variables, visual and perceptual impairments, and psychological and cognitive factors. However, there is a remaining uncertainty about prediction of outcome and a need to clinically apply research findings. This study was designed to identify the relative importance of medical, functional, demographic, and cognitive factors in predicting length of stay in rehabilitation, functional outcome, and recommendations for postdischarge continuation of services.

Methods: The influence of these factors was determined by comparing diagnostic, medical, demographic, functional, and neuropsychological information that was retrospectively obtained by reviewing the records of 86 patients admitted for comprehensive rehabilitation due to stroke (n=36) or orthopedic injury (n=50). Multiple linear regression with statistical adjustment to control for overprediction of variance was used to predict outcomes.

Results: The study revealed the primary importance of higher-order cognitive impairments (comprehension, judgment, short-term verbal memory, and abstract thinking) in extending length of stay and increasing referrals for outpatient therapies and home services after discharge for the cerebrovascular accident patients in comparison with orthopedic cohorts.

Conclusions: The need is discussed for early, comprehensive assessment of deficits in cognition that affect a stroke survivor's ability to participate in a rehabilitation program and remediation that facilitates functional improvement by building on residuals of impaired abilities or teaching compensatory behaviors. (Stroke. 1993;24:1794-1800.)

Key Words • cognition • neuropsychological tests • rehabilitation

With an incidence of 600,000 new cases per year in the United States, stroke stands out as the third leading cause of death, the leading cause of paralysis, and a major cause of disability.1-3 It is the most common diagnosis for those who survive the acute crisis and are referred to rehabilitation hospitals4 with goals of improving physical impairments and functional outcomes, such as activities of daily living.

Research in recent decades has been helpful in identifying variables that affect achievement of these goals. Considerable attention has focused on medical and physical aspects of stroke. For example, medical comorbidities (such as hypertension, diabetes, heart disease5-7), site of lesion,8-10 motor recovery, and bowel/bladder functions11-14 have been found to be significant predictors of physical and functional outcomes. Other studies have revealed the importance of demographic variables (such as age, sex, and ethnicity15-18) as well as visual or perceptual impairments,19-22 communication disturbances,23-25 and psychological and cognitive factors26-32 in predicting rehabilitation outcomes.

Although this research has contributed to an understanding of factors effecting physical and functional recovery from stroke, there is still “substantial uncertainty” about outcome after stroke and a lag in clinical application of research findings.33 This study was designed to identify the relative importance of factors that could lead to improved prediction of clinically relevant outcomes and therefore help clinicians to decide at an early point a patient’s potential for rehabilitation, set realistic plans for treatment during rehabilitation, and develop a discharge plan guided by medical and rehabilitation goals. Specifically, it was intended to determine the importance of medical, functional, demographic, and neuropsychological information in predicting length of stay in a rehabilitation hospital and recommendations for postdischarge continuation of services.
Methodology

Subjects

Eighty-six consecutively admitted inpatients who were referred for comprehensive rehabilitation after a cerebrovascular accident (CVA) or orthopedic injury and surgery were retrospectively studied. The stroke group consisted of 36 patients (mean age, 66 ± 14 years) identified by clinical and radiological evidence of CVA; 39% of the group suffered left hemisphere strokes, 46% had right hemisphere strokes, and 15% experienced bilateral strokes. The current stroke was the second occurrence for five of these patients. Ninety-four percent of this group had one or more comorbidities, particularly cardiovascular and endocrinological problems; 55% of patients were diagnosed with hypertension, 40% with other cardiovascular conditions (ie, arrhythmia, coronary artery and heart disease, myocardial infarction) and 18% with diabetes. Fifty patients (mean age, 75 ± 14 years) with orthopedic conditions composed the comparison group; 34% of the group had knee replacements, 38% had hip replacements, and 28% had hip fractures without prosthetic implantations. Eighty-four percent of the patients in this group had one or more comorbidities; 68% of patients were diagnosed with hypertension, 45% with other cardiovascular conditions, and 26% with diabetes. Two patients in the orthopedic comparison group had a history of momentary change in consciousness due to single occurrences of a transient ischemic attack approximately 10 years before present admission and a psychomotor seizure approximately 15 years before the current admission.

Patients of any age, sex, or race were included in the sample.

Procedure

On admission all patients underwent discipline-specific evaluations by medicine, psychology/neuropsychology, occupational therapy, physical therapy, and speech. As a matter of standard procedure, staff in each discipline obtained relevant clinical information and completed the Functional Independence Measure (FIM) for use in program evaluation. The FIM is an instrument composed of ordinal scales used to subjectively estimate capacity for independence in various areas of functioning, such as self-care, mobility, communication, and cognition.

Additionally, every patient was administered the Neurobehavioral Cognitive Status Examination (NCSE) by a rehabilitation psychologist or psychology intern under supervision. The NCSE is a standardized instrument for assessing separate areas of cognitive functioning, including orientation, attention, language (comprehension, repetition, naming), constructions, memory, calculations, similarities (abstract conceptualization), and (social) judgment. The NCSE was found to outperform traditional mental state examinations, such as the Mini-Mental State Examination, and demonstrate greater sensitivity to cognitive disorders by assessing multiple cognitive areas and using graded series of tasks within each cognitive domain.

Patients followed the course of rehabilitation developed by an interdisciplinary rehabilitation team during hospitalization and were discharged after achieving set goals to designated placements and, if necessary, with specific recommendations for continued treatment. After discharge, the following information was collected from medical records: demographic information (age, sex, education, race); anamnestic information (primary diagnosis, medical comorbidities, CVA history, CVA lateralization, number of CVA sites, CVA location, psychiatric and alcohol/drug abuse histories); clinical manifestations of depression and/or anxiety during psychological interview; admission and discharge FIM scores from each discipline; NCSE test results (10 scores); length of rehabilitation stay; disposition at discharge (home with and without attendant care, nursing home, acute care hospital, deceased); and number of recommended hours for aftercare services (physical therapy, occupational therapy, speech therapy).

Data Analysis

SYSTAT (Version 5.0) was used to perform all analyses. Descriptive statistics were calculated for the CVA
TABLE 2. Product-Moment Correlations Between NCSE Scores, Diagnostic, Functional, Demographic, and Dependent Variables

<table>
<thead>
<tr>
<th>NCSE scores</th>
<th>Length of Stay</th>
<th>Discharge FIM</th>
<th>Attendant Care Hours</th>
<th>Outpatient Therapy Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orientation</td>
<td>-0.52</td>
<td>0.35</td>
<td>0.31</td>
<td>-0.27</td>
</tr>
<tr>
<td>Attention</td>
<td>-0.36</td>
<td>0.13*</td>
<td>0.06*</td>
<td>-0.04*</td>
</tr>
<tr>
<td>Comprehension</td>
<td>-0.59</td>
<td>0.39</td>
<td>0.23</td>
<td>-0.21</td>
</tr>
<tr>
<td>Naming</td>
<td>-0.39</td>
<td>0.33</td>
<td>0.13</td>
<td>-0.14*</td>
</tr>
<tr>
<td>Repetition</td>
<td>-0.32</td>
<td>0.20*</td>
<td>0.10*</td>
<td>-0.13*</td>
</tr>
<tr>
<td>Memory</td>
<td>-0.34</td>
<td>0.40</td>
<td>0.28</td>
<td>-0.35</td>
</tr>
<tr>
<td>Construction</td>
<td>-0.35</td>
<td>0.49</td>
<td>0.37</td>
<td>-0.23</td>
</tr>
<tr>
<td>Calculation</td>
<td>-0.31</td>
<td>0.18*</td>
<td>0.21</td>
<td>-0.24</td>
</tr>
<tr>
<td>Similarities</td>
<td>-0.23</td>
<td>0.37</td>
<td>0.22</td>
<td>-0.21</td>
</tr>
<tr>
<td>Judgment</td>
<td>-0.48</td>
<td>0.38</td>
<td>0.27</td>
<td>-0.33</td>
</tr>
<tr>
<td>CVA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagnosis</td>
<td>0.42</td>
<td>-0.45</td>
<td>-0.29</td>
<td>0.24</td>
</tr>
<tr>
<td>Left hemisphere</td>
<td>0.58</td>
<td>-0.36*</td>
<td>-0.25*</td>
<td>0.35*</td>
</tr>
<tr>
<td>No. of lesions</td>
<td>0.52</td>
<td>-0.40</td>
<td>-0.20*</td>
<td>0.26*</td>
</tr>
<tr>
<td>FIM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OT Admission</td>
<td>-0.65</td>
<td>0.68</td>
<td>0.50</td>
<td>-0.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.00</td>
<td>0.60</td>
<td>-0.32</td>
</tr>
<tr>
<td>PT Admission</td>
<td>-0.59</td>
<td>0.70</td>
<td>0.65</td>
<td>-0.17*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.50</td>
<td>1.00</td>
<td>-0.40</td>
</tr>
<tr>
<td>PSY Admission</td>
<td>-0.63</td>
<td>0.39</td>
<td>0.22</td>
<td>-0.34</td>
</tr>
<tr>
<td></td>
<td>-0.65</td>
<td>0.36</td>
<td>0.23</td>
<td>-0.35</td>
</tr>
<tr>
<td>Affect</td>
<td>0.16*</td>
<td>-0.25</td>
<td>-0.13*</td>
<td>0.22</td>
</tr>
<tr>
<td>Demographics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.16*</td>
<td>-0.25*</td>
<td>-0.13*</td>
<td>0.22</td>
</tr>
<tr>
<td>Functional IQ</td>
<td>-0.20*</td>
<td>0.12*</td>
<td>0.21</td>
<td>-0.14*</td>
</tr>
<tr>
<td>Sex, female</td>
<td>0.28</td>
<td>0.04*</td>
<td>0.08*</td>
<td>0.03*</td>
</tr>
<tr>
<td>Length of stay</td>
<td>1.00</td>
<td>-0.46</td>
<td>-0.33</td>
<td>0.32</td>
</tr>
</tbody>
</table>

NCSE indicates Neurobehavioral Cognitive Status Examination; CVA, cerebrovascular accident; FIM, Functional Independence Measure; OT, occupational therapy; PT, physical therapy; and PSY, psychology.

*pCorrelation not significant at P < .05.

and orthopedic groups, and groups were compared using independent-groups t tests with separate variance estimates (Table 1).

Product-moment correlations were calculated between the independent variables (10 NCSE subscale scores; CVA versus orthopedic diagnosis; CVA hemisphere and number of infarcts; admission occupational therapy [OT] and physical therapy [PT] total FIM scores, admission and discharge psychology FIM scores; presence of depressed affect or anxiety on admission; age; estimated functional intelligence41; sex) and the dependent variables measuring outcome and disposition (length of hospital stay; discharge OT and PT FIM scores; hours of prescribed weekly attendant care; hours of recommended outpatient OT, PT, and speech therapy) (Table 2).

Multiple linear regression was used to predict five dependent variables: length of stay in rehabilitation, OT and PT discharge FIM scores, as well as prescribed attendant care and outpatient treatment hours. Only the five NCSE scores that were significantly different between the two subgroups, CVA diagnosis, and OT and PT FIM scores were included in the regression equations to reduce overfit by limiting the total number of variables. As recommended by Johnson and associates33 shrinkage-adjusted variance was reported to control for overprediction of the explained variance (Table 3).

Results

Descriptive Statistics

Four NCSE scores were found to be significantly lower in the CVA group: similarities, judgment, construction, and memory (see Table 1). Additionally, admission OT, PT, and psychology FIMs as well as OT
discharge FIMs were significantly lower in the CVA group while length of stay was significantly longer. Notably, manifestations of affective symptomatology, such as depression and/or anxiety, were detected during psychological evaluation in many patients regardless of diagnosis; however, the larger number of CVA patients with a disturbance of mood was not statistically different from the orthopedic cases.

Demographic comparisons revealed that the orthopedic group was significantly older than the CVA group and characterized by a higher but statistically nonsignificant tendency for a greater number of women. No differences were observed in estimates of functional intelligence; calculations indicated that both groups were basically average in intelligence.

Approximately 93% of all patients (n=79) went home after rehabilitation, 5% were discharged to a nursing home, 2% were transferred to an acute care hospital, and one patient expired. Eighty-four percent of all patients (n=72) were prescribed outpatient therapies; 100% of these patients were referred for PT, 6% for speech therapy, and 21% for OT. The number of weekly outpatient therapy hours was significantly higher in the CVA group and, notably, only post-CVA patients were recommended for OT. The number of weekly attendant care hours was not significantly different between the two groups.

Length of Stay Prediction

Three NCSE scores (judgment, orientation, and comprehension) produced moderate effect-size correlations that accounted for 23% to 35% of the length of stay variance. Additionally, moderate effect-size correlations accounting for 22% to 42% of the length of stay variance were determined by the diagnosis of a CVA, multiple and left hemisphere infarcts, as well as admission and discharge OT, PT, and psychology FIMs. The remaining NCSE scores, the presence of depressed affect or anxiety on admission and demographic variables correlated less well with length of stay.

Using the NCSE scores, diagnosis, and admission OT, PT, and psychology FIMs, multiple regression predicted 57% of the length of stay variance with only OT and psychology admission FIMs making significant individual contributions.

**OT Discharge FIM Prediction**

Two NCSE scores (memory and construction) produced at least moderate effect-size correlations that accounted for 16% and 24% of the OT discharge FIM score variance. Moderate effect-size correlations accounting for 16% to 49% of the variance of the OT discharge FIM score were also produced by the diagnosis of a CVA, the presence of multiple infarcts, length of stay, OT admission FIM score, as well as admission and discharge PT FIMs. The remaining NCSE scores, the hemisphere of the CVA, psychology FIM scores, the presence of depressed affect or anxiety, and demographic variables resulted in weaker correlations with OT discharge FIM scores.

Using the NCSE scores, diagnosis, and admission OT, PT, and psychology FIMs, multiple regression predicted 51% of the variance of OT discharge FIMs with only OT and PT admission FIMs making significant individual contributions.

### Table 3. Prediction of Outcome and Disposition Using Multiple Linear Regression

<table>
<thead>
<tr>
<th>NCSE scores</th>
<th>Length of Stay</th>
<th>Discharge FIM</th>
<th>Attendant Care Hours</th>
<th>Outpatient Therapy Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>OT</td>
<td>PT</td>
<td></td>
</tr>
<tr>
<td>Similarities</td>
<td>0.94</td>
<td>-0.04</td>
<td>-0.09</td>
<td>-0.18</td>
</tr>
<tr>
<td>Orientation</td>
<td>-1.40</td>
<td>0.02</td>
<td>0.12</td>
<td>0.23</td>
</tr>
<tr>
<td>Judgment</td>
<td>-0.30</td>
<td>0.07</td>
<td>-0.15</td>
<td>-1.06</td>
</tr>
<tr>
<td>Construction</td>
<td>1.31</td>
<td>0.35</td>
<td>-0.01</td>
<td>0.87</td>
</tr>
<tr>
<td>Memory</td>
<td>0.05</td>
<td>0.11</td>
<td>0.24</td>
<td>-0.32</td>
</tr>
<tr>
<td>Diagnosis CVA</td>
<td>0.95</td>
<td>-0.45</td>
<td>-0.15</td>
<td>0.93</td>
</tr>
<tr>
<td>FIM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OT</td>
<td>-2.07a*</td>
<td>0.42a*</td>
<td>0.12a</td>
<td>-0.33d</td>
</tr>
<tr>
<td>PT</td>
<td>-0.87a</td>
<td>0.24a</td>
<td>0.52a*</td>
<td>-0.32d</td>
</tr>
<tr>
<td>PSY</td>
<td>-1.39a*</td>
<td>-0.03a</td>
<td>-0.08a</td>
<td>-0.19d</td>
</tr>
<tr>
<td>Constant</td>
<td>133.96*</td>
<td>13.77*</td>
<td>10.69*</td>
<td>29.85*</td>
</tr>
<tr>
<td>Multiple R</td>
<td>.79</td>
<td>.75</td>
<td>.70</td>
<td>.52</td>
</tr>
<tr>
<td>R²</td>
<td>.62</td>
<td>.57</td>
<td>.49</td>
<td>.27</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>.57</td>
<td>.51</td>
<td>.41</td>
<td>.15</td>
</tr>
<tr>
<td>Probability</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>&lt;.001</td>
<td>.04</td>
</tr>
</tbody>
</table>

(degrees of freedom) (9, 63) (9, 67) (9, 59) (9, 52) (9, 56)

NCSE indicates Neurobehavioral Cognitive Status Examination; CVA, cerebrovascular accident; FIM, Functional Independence Measure; OT, occupational therapy; PT, physical therapy; and PSY, psychology.

*Coefficient significant at P<.05; FIM scores: a=admission; d=discharge.
**PT Discharge FIM Prediction**

Moderate effect-size correlations between PT admission FIM scores and OT admission and discharge FIM scores accounted for 25% to 42% of the variance of the PT discharge FIM score. The remaining NCSE scores, CVA variables, length of stay, admission and discharge psychology FIMs, the presence of affective disturbances, and demographic variables produced weaker correlations with the PT discharge FIM score. Using the NCSE scores, diagnosis, and admission OT, PT, and psychology FIMs, multiple regression predicted 41% of the variance of PT discharge FIM scores with only PT admission FIM scores making a significant individual contribution.

**Prediction of Attendant Care Hours**

Only the PT discharge FIM score produced a moderate effect-size correlation that accounted for 16% of the variance for attendant care hours. The NCSE scores, CVA variables, length of stay, PT admission FIM score, admission and discharge OT and psychology FIMs, the presence of depressed affect or anxiety, and demographic variables were not as strongly correlated with attendant care hours.

Using the NCSE scores, diagnosis, and discharge OT, PT, and psychology FIMs, multiple regression predicted 15% of the variance of attendant care hours. None of the variables made significant individual contributions.

**Prediction of Outpatient Therapy Hours**

Length of stay and all of the FIM scores except the psychology discharge FIM score produced moderate effect-size correlations that accounted for 19% to 28% of the outpatient therapy hours variance. The NCSE scores, CVA variables, psychology discharge FIMs, the presence of depressed affect or anxiety, and demographic variables produced weaker correlations with outpatient therapy hours.

Using the NCSE scores, diagnosis, and discharge OT, PT, and psychology FIMs, multiple regression predicted 41% of the variance of outpatient therapy hours with only NCSE Similarities and Construction scores as well as the OT and PT discharge FIMs making significant individual contributions.

**Discussion**

All rehabilitation programs focus on improving physical and functional abilities as a primary goal for patients. As evidenced by the comparison of admission and discharge FIM scores for PT and OT, all patients admitted for comprehensive rehabilitation achieved this goal; in fact, all patients, regardless of diagnosis on admission, showed nearly the same magnitude of improvement in physical and functional abilities after their rehabilitation stay and almost all returned home.

However, the CVA patients were in poorer physical and functional condition at discharge than the orthopedic cohort, even after twice the length of stay in rehabilitation. Moreover, the CVA patients needed significantly more hours of weekly outpatient therapy after discharge and, although statistically nonsignificant, an apparently greater need for attendant care hours at home than the orthopedic group. Thus, the rehabilitation team should expect on admission that their CVA patients will generally improve with traditional therapies albeit with a longer rehabilitation stay and more hours of attendant care and outpatient therapies after discharge. While these are acceptable outcomes for many patients disabled by stroke, it is important to examine the underlying reasons for the extended stays and more extensive aftercare of CVA patients.

Because research has demonstrated that major depression or dysthymic disorders occur in 20% to 63% of stroke patients in acute care or rehabilitation facilities42-45 and can affect rehabilitation recovery,32,46 the role of affective disorders had to be considered in this regard. Notably, while 50% of the stroke patients in this study manifested evidence of depression, a finding consistent with estimates of poststroke depression, the correlations between depression and functional recovery, length of stay, and aftercare recommendations were not significant, and a comparable degree of affective disturbance was found in the orthopedic cohort. While depression was not found to be a major factor determining length of stay or recommendations for aftercare, the finding does not necessarily mean that a diagnosis of depression has no effect on rehabilitation outcome for stroke patients; the effect of depression on patients' response to outpatient therapies or postdischarge functioning was not assessed in this study. Further study of the effects of depression on the need for continued services is warranted in light of evidence that depression is most prevalent and most severe at approximately 6 months after stroke.45

The results of this study indicate that deficits in cognition, particularly higher-order cognitive abilities (e.g., abstract thinking, judgment, short-term verbal memory, comprehension, orientation) play an important role in determining length of stay and in predicting functional status at the end of the hospital stay as suggested by earlier studies.20,28,47,48 This finding should not be surprising to rehabilitation specialists who recognize the importance of the patient's awareness and understanding of his or her impairments, and the relationship of this insight to the capacity to learn and carry over functional skills from day to day, or even “remembering-to-remember” to initiate or complete a task. Consequently, the CVA patients who enter rehabilitation, often with severe cognitive deficits, should be expected to take longer than even the older orthopedic cohort to appreciate their condition as well as to acquire and retain the physical and cognitive skills necessary for activities of daily living. Unfortunately, even patients who improve physically may not show comparable improvement in cognition, and therefore may leave rehabilitation with a lesser degree of functional independence and a greater need for follow-up services.

Moreover, deficits in cognition should also be taken into account when considering postdischarge services for CVA patients who leave rehabilitation in poorer physical condition and more impaired in self-care and daily living activities than the orthopedic cohort. Interestingly, while PT was recommended equally for the CVA and orthopedic groups, only 50% of the CVA patients received team recommendations for outpatient OT. Considering that cognitive abilities, such as the ability for conceptualization, short-term memory, and constructional ability, significantly contributed to the variance associated with the prediction of outpatient
therapy hours and are addressed by OT in training activities of daily living, it is difficult to understand why postdischarge OT was not as consistently recommended for the CVA patients as PT.

It is also unclear from the data why stroke survivors failed to receive a significantly greater number of recommendations for attendant care and why only 15% of the variance associated with attendant care hours was predicted by cognitive and functional measures that were significantly more impaired for CVA than the orthopedic patients. These findings are most likely explained by limitations of insurance coverage, particularly Medicare, which limits attendant care at home to 6 hours per week. Since the physical and functional disabilities in both the CVA and orthopedic patients necessitated home care, the recommended number of hours probably represented the maximum number of home care hours that could be allowed by Medicare.

This study also indicates the importance of cognitive factors in the rehabilitation of stroke survivors, including the broad-based evaluation of deficits in learning, memory, and other aspects of cognition that affect the ability to engage in and benefit from rehabilitation. It points to the usefulness of early neuropsychological screenings with tools, such as the NCSE, that provide quantitative estimates of individual aspects of cognition rather than a global estimate of cognitive impairment. Such screening instruments could provide clinicians with specific information about a patient’s cognitive strengths and weaknesses shortly after admission and facilitate remediation of specific deficits.

Furthermore, findings from the study suggest the importance of cognitive remediation in building on residuals of lost or impaired cognitive skills or teaching ways to compensate for any cognitive impairments in cerebrally compromised patients. Unfortunately, insurance companies do not usually recognize the value of such treatment. Therefore, patients are forced to receive piecemeal approximations of cognitive remediation from occupational or speech therapists rather than from an interdisciplinary team with comprehensive goals. Moreover, vocational goals, when addressed, must be handled by state agencies or separate rehabilitation specialists rather than being incorporated into the plans of an interdisciplinary team.

Overall, these results suggest that early assessment and remediation of cognitive impairments in stroke survivors could facilitate physical and functional improvement during rehabilitation, decrease length of stay, and reduce the needs for aftercare services. Ultimately, more rapid and cost-effective rehabilitation as well as greater functional independence could be expected for stroke patients on discharge home.

References
Predicting length of stay, functional outcome, and aftercare in the rehabilitation of stroke patients. The dominant role of higher-order cognition.

T Galski, R L Bruno, R Zorowitz and J Walker

Stroke. 1993;24:1794-1800
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The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/24/12/1794