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OBJECTIVE. A subgroup of patients benefiting most from robot-assisted therapy (RT) has not yet been described. We examined the predictors of improved outcomes after RT.

METHOD. Sixty-six patients with stroke receiving RT were analyzed. The outcome measures were the Fugl-Meyer Assessment (FMA), Wolf Motor Function Test (WMFT), Motor Activity Log (MAL), and Stroke Impact Scale (SIS). The potential predictors were age, side of lesion, time since onset, Modified Ashworth Scale (MAS) scores, accelerometer data, Box and Block Test (BBT) scores, and kinematic parameters.

RESULTS. BBT scores were predictive of FMA (29%) and MAL (9%—15%) improvements. Reduced shoulder flexion synergy, as measured by less shoulder abduction during forward reach, and MAS–distal were predictive of WMFT–function improvements. MAS–distal was predictive of SIS–physical improvements. Demographic variables did not predict outcomes.

CONCLUSION. Manual dexterity was a valuable predictor of motor impairment and daily function after RT. Outcomes at different levels may have different predictors.


Using robotic devices to achieve highly intensive, task-specific, reproducible, and interactive practice brings a relatively new scientific concept to clinical practice (Harwin, Patton, & Edgerton, 2006; Waldner, Tomelleri, & Hesse, 2009). Robot-assisted therapy (RT) shows great promise for patients with stroke and has had a significant impact on neurorehabilitation during the past 15 yr (Hesse et al., 2005; Hsieh et al., 2011; Lo et al., 2010; Volpe et al., 1999). The results of meta-analyses support the treatment efficacy of RT in the arm on motor and functional outcomes in stroke patients (Kwakkel, Kollen, & Krebs, 2008; Mehrholz, Platz, Kugler, & Pohl, 2008).

After a decade of research on stroke rehabilitation using RT, a subgroup of patients who may benefit most from this type of therapy still cannot be clearly defined (Dobkin, 2009). We know many factors interact with and affect the outcomes of stroke rehabilitation (Franceschini et al., 2012). However, existing evidence on this topic is limited. Given the growing accessibility of RT, the identification of predictors to tailor treatment plans and more accurately stratify patients toward a better outcome of stroke rehabilitation is also of value to clinicians and researchers (Brewer, McDowell, & Worthing-Chaudhari, 2007).

We conducted this study to identify the predictors of outcomes in stroke patients after RT to help target the optimized individuals to receive the intervention. The candidate predictors were age; side of lesion; time since stroke...
onset; muscle tone in distal hand; hand usage in daily life; manual dexterity; and joint movements of shoulder, elbow, and trunk. These predictors were selected on the basis of previous studies of specific stroke rehabilitation interventions other than RT. For instance, studies have found that time since stroke, side of stroke lesion, finger extension, and Fugl-Meyer Assessment (FMA; Fugl-Meyer, Jääskö, Leyman, Olsson, & Steglin, 1975) arm and distal part scores were predictive of improved outcomes after constraint-induced therapy or bilateral arm training (Fritz et al., 2006; Fritz, Light, Patterson, Behrmann, & Davis, 2005; Kwakkel, Kollen, van der Grond, & Prevo, 2003; Lin, Huang, Hsieh, & Wu, 2009; Park, Wolf, Blanton, Weinstein, & Nichols-Larsen, 2008; Waller & Whitall, 2005).

One unique aspect of this study is that we included kinematic measures quantifying movement quality in the paretic arm (Roby-Brami et al., 2003) at baseline assessments as potential predictors. We used these kinematic data to quantify flexion synergy (i.e., abduction and external rotation of the shoulder, elbow flexion, and forearm supination while elevating the paretic arm), which is one common upper-extremity (UE) synergy after stroke (Brunnstrom, 1970). This abnormal synergy makes extending the elbow of the paretic hand difficult (Messier, Bourbonnais, Desrosiers, & Roy, 2006). Also included as potential predictors were trunk flexion, as an indicator of compensatory movement because of UE synergy, and accelerometry data. Accelerometry is an objective measure to monitor actual use of affected extremities and has been used to validate the Motor Activity Log (MAL; Uswatte et al., 2006).

Our research question was, What are the predictors of outcomes after RT in stroke rehabilitation? We aimed to develop predictive models of outcome improvement from baseline to posttreatment. Predictors that significantly contributed to the changes in motor impairment (measured by the FMA), motor function (measured by the Wolf Motor Function Test [WMFT; Wolf et al., 2001]), daily function (measured by the MAL), and self-perceived quality of life (measured by the Stroke Impact Scale [SIS; Lai, Studenski, Duncan, & Perera, 2002]) were determined.

Method

Research Design

This study was a secondary analysis of data from cohorts receiving RT therapy in previous studies (Hsieh et al., 2012; Yang, Lin, Chen, Wu, & Chen, 2012) and in an ongoing project. Eligible participants received RT inter-

ventions with the Bi-Manu-Track device (Reha-Stim Co., Berlin, Germany) for 90–105 min/day, 5 days/wk for 4 wk. Assessments were administered at baseline and after treatment. A correlational design and linear regression analysis was used to determine the demographic and baseline scores that significantly predicted improved outcomes. The institutional review boards of the participating hospitals approved the trials, and all participants provided informed consent.

Participants

The study originally enrolled 66 participants from three studies of RT treatment effects after stroke. The inclusion criteria for all studies were (1) ≥3 mo onset from a unilateral stroke; (2) FMA UE score >18 (Hesse et al., 2005); (3) no excessive spasticity in forearm and wrist joints (Modified Ashworth Scale [MAS; Bohannon & Smith, 1987]) score <3; (4) able to follow study instructions and perform study tasks (Mini-Mental State Examination score ≥20; Castro-Costa, Fuzikawa, Uchoa, Firmo, & Lima-Costa, 2008); (5) no UE fracture ≤3 mo and no painful arthritis or contracture of the joints; and (6) no severe neuropsychologic impairments (e.g., global aphasia or severe attention deficits).

Outcome Measures

We selected outcome measures to follow the International Classification of Functioning, Disability and Health (World Health Organization, 2001) framework to facilitate interpretability of our results (Lemmens, Timmermans, Janssen-Potten, Smeets, & Seelen, 2012). Motor impairments were measured by the FMA; motor function, by the WMFT; daily function, by the MAL; and quality of life, by the SIS–physical subscale. The Upper-Extremity (UE) subscale of the FMA (Fugl-Meyer et al., 1975) was used to assess motor impairment outcomes. The FMA–UE consists of 33 items measuring the movement and reflexes of the shoulder, elbow, forearm, wrist, and hand, as well as coordination and speed, on a 3-point ordinal scale (2: can perform fully). Higher FMA–UE scores indicate less motor impairment. The change scores of the FMA–UE from baseline to posttreatment were calculated as the dependent variables in the linear regression analyses. The FMA–UE has good reliability (r > .95) and validity (p = .49–.73) in stroke patients (Hsieh et al., 2009; Platz et al., 2005).

UE function was assessed with the WMFT, which consists of two scales: performance time and functional ability. The WMFT has good reliability (r = .86–.99; Morris, Uswatte, Crago, Cook, & Taub, 2001) and criterion validity (p = .45–.77; Hsieh et al., 2009) and has
been widely used as an outcome measure in stroke motor rehabilitation trials (Whitall et al., 2011). This study used the functional ability scale (WMFT–function) only, because the collected data did not show statistically significant changes in the time subscale before and after treatment.

The MAL, a functional and patient-reported outcome measure, captures the amount of use (AOU) and quality of movement (QOM) while the patients use their affected arm to accomplish 30 daily activities. The score ranges from 0 to 5; higher scores indicate better performance. The MAL in stroke patients has been reliable ($r \geq .91$) and valid (Cronbach’s $\alpha > .87$, $\rho = .63$; Lang, Edwards, Birkenmeier, & Dromerick, 2008; van der Lee, Beckerman, Knol, de Vet, & Bouter, 2004).

A self-reported quality-of-life measure, the SIS was used to assess the difficulty level in performing activities during the preceding week. A 5-point Likert scale was used in each scale, with higher scores indicating better function. We used the composite score of the SIS–physical domain, which was computed using the strength, activity of daily living, mobility, and hand function subscores. Previous studies have established the reliability ($r = .96$) and validity ($\rho = .61$; Carod-Artal, Coral, Trizotto, & Moreira, 2008) of the SIS.

**Potential Predictors**

This study selected three demographic, three motor functional, and four kinematic assessments as initial candidate predictors, which were recorded or assessed at baseline. The three demographic predictors were age, side of lesion, and time since stroke onset, which were found to be relevant and important in previous outcome prediction research (Kwakkel et al., 2003). The three motor functional predictors were UE distal muscle tone measured by the MAS–distal, hand usage in daily life measured by accelerometers, and manual dexterity measured by the Box and Block Test (BBT; Mathiowetz, Volland, Kashman, & Weber, 1985). The four kinematic variables selected as predictors were degrees of shoulder flexion, shoulder abduction, elbow extension, and trunk flexion during forward reach.

**Motor and Functional Predictors.** The MAS is a reliable scale for assessing muscle tone in stroke patients; scores range from 0 (no increase in muscle tone) to 5 (rigid). The Spearman’s $\rho$ reflecting the intrarater reliability of MAS has been found to range from .56 to .90 (Sloan, Sinclair, Thompson, Taylor, & Pentland, 1992). MicroMini-Motionlogger accelerometers (Ambulatory Monitoring, Ardsley, NY) were used to monitor arm activity in the participants’ natural environments. Patients wore the accelerometer nearly 24 hr daily (removed when bathing) for 3 consecutive days before and after treatment. Compliance, monitored by the examiners and the analytic software, was reported as good. Accelerometers have demonstrated sufficient reliability ($r = .85$) and validity ($r = .52−.98$; Gebruers, van Roy, Tijburg, Engelborghs, & De Deyn, 2010). Values of affected hand activity level and the ratio of affected to unaffected hand activity level, measured by accelerometer, were used for this study.

The BBT is a measure of manual dexterity with satisfactory reliability ($r = .94−.99$) and validity ($\rho = .35−.80$; Lin, Chuang, Wu, Hsieh, & Chang, 2010; Mathiowetz et al., 1985). Participants use the affected hand to move as many blocks as possible from one compartment to another within 1 min. The BBT score is the number of blocks transferred by the affected hand.

**Kinematic Predictors.** Participants were instructed to reach forward with their affected hand to press a desk bell as fast as possible while sitting on a height-adjustable, straight-back chair with seat height at 100% of lower leg length. The table height was adjusted so that the initial position of the hand was on the edge of the table with the elbow flexed at 90°. A 7-camera VICON MX motion capture system (Oxford Metrics, Oxford, England), at a sampling frequency of 120 Hz, was used with a personal computer to record kinematic data. Kinematic data were processed with an analysis program coded by LabVIEW language (National Instruments, Austin, TX). Kinematic variables included degree of movement of shoulder flexion and abduction, elbow extension, and trunk flexion. *Degree of movement* was defined as the difference of angle change from movement onset to offset. Kinematic analysis has demonstrated good accuracy (Carse, Meadows, Bowers, & Rowe, 2013) and test–retest reliability for kinematic variables (Wu, Yang, Chen, Lin, & Wu, 2013).

**Data Collection**

Pretest and posttest evaluations were conducted by examiners blinded to the participant group. Before the examiners conducted the assessments, the principal investigators (Lin and Wu) of this study trained them and reviewed their performance in administering the tests.

**Data Analysis**

The normality of each variable was statistically verified by the value of skewness ($\pm 1$) and visually verified using histograms. All the variables in this study met the assumptions of normality. Regression analyses were performed to identify significant predictors. The variance
inflation factor was used to examine the presence of multicollinearity (redundancy) among the predictors. The initially chosen candidate predictors were entered into the predictive models according to the strength of the bivariate correlations (Pearson’s $r$; criteria of $p < .20$; Wee & Hopman, 2005). Multiple linear regression analyses with a forward stepwise procedure were used to predict the change scores on the FMA, WMFT–function, MAL–AOU, MAL–QOM, and the SIS–physical by entering the pretest scores of these outcomes as covariates. Statistical analyses were performed using IBM SPSS Statistics Version 16.0 (SPSS, Inc., Chicago).

**Results**

The study analyzed data from all 66 participants (45 men), with a mean age of 53 yr. Mean stroke onset was 23 mo, the stroke was ischemic in 39 patients, and the lesion was in the right hemisphere in 34 patients (Table 1).

Table 2 summarizes the relationships among the remaining candidate predictors and the change scores of the outcomes. All outcomes showed statistically significant improvements from pretest to posttest. The four predictors of time since stroke, accelerometer-affected hand activity level, BBT score, and elbow extension were entered into the model with FMA–UE as the dependent variable. The four predictors of MAS–distal score, BBT, shoulder flexion, and shoulder abduction were entered into the model with WMFT–function as the dependent variable. The three predictors of time since stroke, MAS distal score, and BBT were entered into the models with MAL–AOU and MAL–QOM as the dependent variables. The four predictors of side of lesion, MAS distal score, shoulder flexion, and shoulder abduction were entered into the model for prediction of SIS–physical.

Table 3 summarizes the results of multiple linear regression analyses. The BBT score was the significant predictor. The model accounted for 29% of the variance in change scores of the FMA. A higher baseline BBT score was associated with greater FMA improvement. For WMFT–function, shoulder abduction during forward reach and MAS distal score were the two significant predictors. The model accounted for 16% of variance in change in WMFT–function. Lower baseline scores of shoulder abduction and MAS distal score at baseline predicted greater WMFT–function improvement.

MAL–AOU and MAL–QOM revealed one common significant predictor, BBT score. Time since stroke, although correlated at .25 (see Table 2), was not included in the final regression solution, having been thrown out by the program because of its correlation with BBT scores. The models accounted for 9% and 15% of the variance in MAL–AOU and MAL–QOM change scores, respectively.

The MAS–distal score accounted for 21% of the variance in SIS–physical, with a lower MAS–distal score predicting greater improvement in SIS–physical score. No strong multicollinearity was found among the predictors for these models (the largest variance inflation factor = 1.98).

**Discussion**

This study is among the first to investigate the possible clinical characteristics of stroke patients that can predict the treatment effects after UE RT. Our results indicate that manual dexterity is a valuable predictor. Patients with higher BBT baseline scores made more improvements on the FMA, the MAL–AOU, and the MAL–QOM after the RT. The BBT, however, predicted only 9%–29% of the variance associated with improvement. In addition, patients who had less shoulder abduction while performing reaching tasks at baseline were likely to make greater improvement on the WMFT. Lower ratings on the MAS–distal at baseline predicted greater positive changes on the WMFT. Lower MAS–distal scores also significantly predicted better SIS–physical scores.

**Manual Dexterity**

Our findings suggest that manual dexterity, as a requirement for some activities (Geyh et al., 2004), seems to be critical in regaining motor function after RT. This
finding is similar to previous results. Multiple studies have found baseline performance of finger extension or FMA to be significantly associated with improvement in motor function after stroke (Fritz et al., 2005; Kwakkel & Kollen, 2007; Kwakkel et al., 2003; Lin et al., 2009). The BBT, a 1-min test for assessing manual dexterity, is easy to administer and can significantly predict a person’s change on motor and functional outcomes. Consequently, the BBT is likely to be a suitable and convenient screening criterion for further RT trials.

Patients with higher manual dexterity had greater gains in AOU and QOM while using their affected hand in executing daily activities. This result is concordant with previous studies showing that manual dexterity greatly affected stroke patients’ ability to independently perform activities of daily living (Rand & Eng, 2010; van Heuvelen, Kempen, Brouwer, & de Greef, 2000; Yancosek & Howell, 2009), was associated with the hand AOU (Rand & Eng, 2010) in older adults, and predicted the living status (totally independent, living at home with social assistance, or nursing home) in older women.

**Compensatory Movement (Shoulder Abduction) and Muscle Tone (MAS–distal)**

Our results reveal that less shoulder abduction during forward reach (an indication of lessened flexor synergy) and less distal muscle tone at baseline significantly predicted motor function outcome, as measured by WMFT–function. This finding suggests that patients with less shoulder–elbow synergy at baseline might benefit more than those with greater synergy. Some studies have shown that an increase in generation of elbow flexion torque was accompanied by increased levels of shoulder abduction in people with hemiparesis (Beer, Given, & Dewald, 1999; Dewald, Pope, Given, Buchanan, & Rymer, 1995). This poor synergy between the elbow and shoulder makes extending the elbow of the paretic hand difficult (Messier et al., 2006).

### Table 2. Correlations Between the Candidate Predictors and the Outcomes (Pearson’s $r$)

<table>
<thead>
<tr>
<th>Candidate Predictor</th>
<th>Side of Lesion</th>
<th>Time Since Onset</th>
<th>MAS–distal</th>
<th>Accelerometer Activity Level</th>
<th>BBT</th>
<th>Shoulder Flexion</th>
<th>Shoulder Abduction</th>
<th>Elbow Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMA–UE</td>
<td>$-0.25$</td>
<td></td>
<td></td>
<td>0.17</td>
<td>0.35</td>
<td></td>
<td></td>
<td>$-0.18$</td>
</tr>
<tr>
<td>WMFT–function</td>
<td></td>
<td></td>
<td></td>
<td>0.20</td>
<td>0.20</td>
<td>$-0.24$</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>MAL–AOU</td>
<td>$-0.25$</td>
<td></td>
<td></td>
<td>0.34</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAL–QOM</td>
<td>$-0.25$</td>
<td></td>
<td></td>
<td>0.39</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIS–physical</td>
<td>0.21</td>
<td>$-0.25$</td>
<td></td>
<td></td>
<td>0.19</td>
<td>0.19</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. AOU = amount of use; BBT = Box and Block Test; FMA–UE = Fugl-Meyer Assessment—Upper Extremity; MAL = Motor Activity Log; MAS = Modified Ashworth Scale; SIS = Stroke Impact Scale; QOM = quality of movement; WMFT = Wolf Motor Function Test.

*aOnly correlations with $p < .20$ are shown.

### Table 3. Multiple Linear Regression Analysis for Prediction of Changes in Outcomes

<table>
<thead>
<tr>
<th>Model</th>
<th>Predictor</th>
<th>$B^a$</th>
<th>$\beta^b$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMA–UE: $F(2, 56) = 12.73, p &lt; .01, Adjusted $R^2 = .288$</td>
<td>Constant</td>
<td>8.01</td>
<td></td>
<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>BBT</td>
<td>0.18</td>
<td>.78</td>
<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>Covariate</td>
<td>$-0.15$</td>
<td>$-0.51$</td>
<td>.02</td>
</tr>
<tr>
<td>WMFT–function: $F(3, 61) = 5.12, p &lt; .05, Adjusted $R^2 = .162$</td>
<td>Constant</td>
<td>6.28</td>
<td></td>
<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>BBT</td>
<td>0.10</td>
<td>.26</td>
<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>Covariate</td>
<td>$-0.02$</td>
<td>$-.08$</td>
<td>.51</td>
</tr>
<tr>
<td></td>
<td>Shoulder abduction</td>
<td>$-0.12$</td>
<td>$-.35$</td>
<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>MAS–distal</td>
<td>$-1.24$</td>
<td>$-2.8$</td>
<td>.03</td>
</tr>
<tr>
<td>MAL–AOU: $F(2, 63) = 4.32, p &lt; .05, Adjusted $R^2 = .093$</td>
<td>Constant</td>
<td>4.18</td>
<td></td>
<td>.07</td>
</tr>
<tr>
<td></td>
<td>BBT score</td>
<td>0.07</td>
<td>.10</td>
<td>.45</td>
</tr>
<tr>
<td></td>
<td>Covariate</td>
<td>0.29</td>
<td>.29</td>
<td>.04</td>
</tr>
<tr>
<td>MAL–QOM: $F(2, 63) = 6.68, p &lt; .05, Adjusted $R^2 = .149$</td>
<td>Constant</td>
<td>3.31</td>
<td></td>
<td>.12</td>
</tr>
<tr>
<td></td>
<td>BBT score</td>
<td>0.12</td>
<td>.18</td>
<td>.18</td>
</tr>
<tr>
<td></td>
<td>Covariate</td>
<td>0.28</td>
<td>.30</td>
<td>.03</td>
</tr>
<tr>
<td>SIS–physical: $F(2, 62) = 9.72, p &lt; .01, Adjusted $R^2 = .214$</td>
<td>Constant</td>
<td>35.58</td>
<td></td>
<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>BBT score</td>
<td>35.58</td>
<td></td>
<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>Covariate</td>
<td>$-1.80$</td>
<td>$-.44$</td>
<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td>MAS–distal</td>
<td>$-1.11$</td>
<td>$-3.6$</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

Note. AOU = amount of use; BBT = Box and Block Test; FMA–UE = Fugl-Meyer Assessment—Upper Extremity; MAL = Motor Activity Log; MAS = Modified Ashworth Scale; SIS = Stroke Impact Scale; QOM = quality of movement; WMFT = Wolf Motor Function Test.

*a$ indicates the nonstandardized coefficient. $b$ indicates the standardized coefficient.

Pretest scores as covariates.
We also found that less initial muscle tone predicted greater improvements in the WMFT and self-perceived physical function after RT. Less initial muscle tone in the distal UE might have been associated with less interference in performing tasks involving hand manipulation in the WMFT, such as better finger extension. A prospective cohort study by Formisano et al. (2005) indicated that patients with spasticity initially showed no further improvement after 2 mo of rehabilitation, whereas flaccid patients continued to show motor recovery. Formisano et al. (2005) proposed that recovery mechanisms emerge later or proceed more slowly in flaccid patients. Therefore, flaccid patients may have more potential than spastic patients and, consequently, gain more benefits from RT.

Understanding the factors that are not important predictors of outcomes after treatment is as crucial as knowing the significant predictors (Fritz et al., 2005). The regression analyses included demographic variables, hand usage measured by accelerometers, and some kinematic parameters (i.e., shoulder flexion, elbow extension, and trunk flexion), but these data were not significant to the prediction of improvement after RT. The use of the accelerometers has challenges; for example, patients might have had unusually active or inactive routines for the sampled 3 days while wearing the accelerometers. Our results also suggested that kinematic measures of range of motion were not significant predictors for any outcomes we measured except WMFT–function. No demographic variables significantly predicted outcomes. These results are inconclusive, however. The significant predictors we found accounted for limited variation in outcomes. Other potential predictors, such as a composite score indicating synergistic versus nonsynergistic movement or sensation, were not addressed in this study. Further inquiry may include more potential predictors in a larger scale study to validate and improve the current results.

Conclusions

We found that manual dexterity seems valuable in predicting improvements in motor impairment and daily function. In addition, factors related to more normal movement, such as reduced shoulder abduction during forward reach and less distal muscle tone, are related to improvements at motor function and quality-of-life levels. We suggest further studies to include additional potential factors, such as sensation, endurance, depression, and motivation, with a larger sample to study the potential contributors of these factors in mediating treatment success after RT or other rehabilitation interventions. Our findings may also be applied to other treatments sharing similar characteristics, such as high intensity, consistency, and assistance with movement in the face of weakness of RT.

Implications for Occupational Therapy Practice

The findings of this study have the following implications for occupational therapy practice:
- Patients with stroke who initially demonstrate good manual dexterity, as measured by the BBT, may have a better chance than those who do not to improve UE motor impairment and daily function; therefore, they should receive intensive therapy as is offered by RT, for example.
- Factors related to typical movement, such as reduced shoulder abduction during forward reach and less distal muscle tone, are related to improvements at motor function and quality-of-life levels.
- None of the demographic variables used in this study (i.e., age, side of lesion, and time since stroke onset) predicted improved motor function or daily function of UE and therefore should not be used to limit participation in intensive rehabilitation.
- Only 29% of the variance associated with improved movement control was accounted for by the chosen predictor variables in this study; therefore, 71% of the variance has not been accounted for and may be found in mental attitude or other variables not included in this study. Patients should not be excluded from intensive therapy only on the basis of dexterity testing. Further study illuminating a greater understanding of characteristics associated with recovery from stroke is needed.

Acknowledgments

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References


