Determinants of Change in Stroke-Specific Quality of Life After Distributed Constraint-Induced Therapy

Yan-Hua Huang, Ching-Yi Wu, Keh-Chung Lin, Yu-Wei Hsieh,
Wilaiwan M. Snow, Tien-Ni Wang

MeSH TERMS

- outcome assessment (health care)
- quality of life
- restraint, physical
- stroke

OBJECTIVE. We identified the predictive factors of change in quality of life (QOL) after a distributed form of constraint-induced therapy (dCIT) among stroke survivors.

METHOD. Seventy-four participants were treated with dCIT. We identified eight potential determinants of change: age, gender, side of lesion, time since stroke, cognitive status, motor impairment of the upper extremity, activities of daily living (ADLs), and instrumental ADLs (IADLs). The Stroke-Specific Quality of Life Scale (SS-QOL) was used to assess QOL.

RESULTS. Right-sided lesion and onset >17 mo earlier determined greater improvement in the SS-QOL Energy domain. Onset >10 mo earlier, poorer IADL performance, and age >68 yr predicted improvement in the Family Role, Mobility, and Mood domains, respectively.

CONCLUSION. Side of lesion, time since stroke, IADL performance, and age were the most important determinants of QOL in patients receiving stroke motor rehabilitation.

Yan-Hua Huang, PhD, OTR/L, is Associate Professor, Department of Occupational Therapy, School of Health and Human Services, College of Professional Studies, California State University, Dominguez Hills.

Ching-Yi Wu, ScD, OTR, is Professor and Chair, Department of Occupational Therapy and Graduate Institute of Behavioral Science, College of Medicine, Chang Gung University, Taoyuan, Taiwan.

Keh-Chung Lin, ScD, OTR, is Professor and Chair, School of Occupational Therapy, College of Medicine, National Taiwan University, 17, F4, Xu Zhou Road, Taipei, Taiwan 100, and Director, Division of Occupational Therapy, Department of Physical Medicine and Rehabilitation, National Taiwan University Hospital, Taipei; kehchunglin@ntu.edu.tw

Yu-Wei Hsieh, PhD, is Assistant Professor, Department of Occupational Therapy and Graduate Institute of Behavioral Science, College of Medicine, Chang Gung University, Taoyuan, Taiwan.

Wilaiwan M. Snow, PhD, is Assistant Professor, Department of Occupational Therapy and Faculty of Associated Medical Sciences, Chiang Mai University, Chiang Mai, Thailand.

Tien-Ni Wang, PhD, is Assistant Professor, School of Occupational Therapy, College of Medicine, National Taiwan University, Taipei.

Huang, Y.-H., Wu, C.-Y., Lin, K.-C., Hsieh, Y.-W., Snow, W. M., & Wang, T.-N. (2013). Determinants of change in stroke-specific quality of life after distributed constraint-induced therapy. *American Journal of Occupational Therapy*, 67, 54–63. <http://dx.doi.org/10.5014/ajot.2013.004820>

A goal of stroke rehabilitation is to improve health-related quality of life (HRQOL) for stroke survivors. The importance of HRQOL has been recognized in many stroke clinical trials. Identifying determinants of changes in quality of life (QOL) after rehabilitation can help rehabilitation professionals set relevant rehabilitation targets to improve HRQOL for stroke survivors (Algurén, Fridlund, Cieza, Sunnerhagen, & Christensson, 2012).

Constraint-induced therapy (CIT) and its distributed form (dCIT) have been advocated for use in stroke rehabilitation to improve a multitude of functional outcomes (Boake et al., 2007; Dettmers et al., 2005; Lin, Huang, Hsieh, & Wu, 2009; Lin, Wu, Liu, Chen, & Hsu, 2009; Lin et al., 2007; Rowe, Blanton, & Wolf, 2009; Sunderland & Tuke, 2005; Wu, Chen, Chen, Lin, & Yeh, 2012; Wu, Chen, Tsai, Lin, & Chou, 2007). CIT involves constraint of the unaffected upper extremity (UE), allowing the use of only the affected arm daily for 2 wk (Sunderland & Tuke, 2005). CIT has been modified to dCIT, a less intensive form that involves 2–3 hr of training of the affected arm combined with 6–9 hr of daily restraint of the unaffected arm for 2–4 wk (Boake et al., 2007; Dettmers et al., 2005; Lin et al., 2007; Lin, Huang, et al., 2009; Wu et al., 2007). Several randomized controlled trials have demonstrated that CIT and dCIT are effective in improving QOL for stroke patients (Lin, Chang, Wu, & Chen, 2009; Lin, Wu, et al., 2009; Lin et al., 2007; Rowe et al., 2009; Wu et al., 2007).

The Stroke Impact Scale (SIS) and the Stroke-Specific Quality of Life (SS-QOL) Scale, which are often used in CIT studies (Kissela, 2006; Lin et al.,

2010; Lin, Wu, et al., 2009; Williams, Weinberger, Harris, & Biller, 1999), are the most comprehensive stroke-specific QOL assessments that measure QOL among stroke survivors (Salter, Moses, Foley, & Teasell, 2008). The SS-QOL is more comprehensive than the SIS and includes more domains, among them Personality, Energy, Vision, Thinking, Work-Productivity, Family Roles, and Social Roles. These domains are important because they may significantly influence a stroke survivor's QOL. The SS-QOL has been widely used internationally to assess the HRQOL outcome of stroke survivors (Ewert & Stucki, 2007; Hilari, Byng, Lamping, & Smith, 2003; Lima, Teixeira-Salmela, Magalhães, & Gomes-Neto, 2008; Muus, Williams, & Ringsberg, 2007; Schmid et al., 2009; Teixeira-Salmela, Neto, Magalhães, Lima, & Faria, 2009; Vrdoljak & Rumboldt, 2008).

Although several studies have reported that motor ability of the distal part of the arm, time since stroke, age, and gender can predict improvement in motor performance after CIT (Lin, Huang, et al., 2009; Rijntjes et al., 2005), the potential predictors of HRQOL improvement after CIT have received scant attention. Only one previous study has examined the predictors of HRQOL as measured with the SIS after dCIT. The seven variables of age, gender, side of lesion, time since stroke, cognitive status, motor impairment, and activities of daily living (ADLs) were used as potential predictors of SIS scores (Huang, Wu, Hsieh, & Lin, 2010). FIM™ (Uniform Data System for Medical Rehabilitation, 1997¹) scores for basic ADLs are predictive of SIS scores. However, basic ADLs are not comprehensive enough for the range of activities relevant to function and to explain HRQOL (Coster, Haley, Jette, Tao, & Siebens, 2007; Hartman-Maeir, Soroker, Ring, Avni, & Katz, 2007). The inclusion of an instrumental ADL (IADL) measure may improve understanding of the person's independence in extended ADLs and the ability to possibly predict HRQOL after dCIT.

IADLs include shopping, cooking, housekeeping, use of transportation, money management, care of others, child rearing, communication management, community mobility, health management and maintenance, home establishment and management, religious observance, safety, and emergency maintenance (American Occupational Therapy Association, 2008; Garcia & McCarthy, 2000). The literature has suggested that IADLs are related to QOL for stroke patients (Hartman-Maeir et al., 2007;

Sveen, Thommessen, Bautz-Holter, Wyller, & Laake, 2004), and the IADL leisure domain is associated with well-being and life satisfaction after stroke (Sveen et al., 2004). Improved IADL ability after training appeared to accelerate recovery in some HRQOL domains (Hartman-Maeir et al., 2007). We therefore included an assessment of IADL performance as a possible predictor for change in QOL after dCIT, which to our knowledge has not been investigated.

The χ^2 automatic interaction detector (CHAID) is a data-mining approach that uses categorical statistics to provide detailed information about interactions among predictor variables and outcome measures. One advantage of CHAID is that it allows all predictors measured at nominal, interval, and ordinal levels (Kass, 1980). Unlike traditional statistical modeling systems, such as regression analysis, which evaluates relational statistics or estimates linear parameters for statistical prediction, CHAID uses categorical statistics (χ^2 , analysis of variance) to devise a decision tree that identifies variables that differentiate the sample into subgroups and separate individuals within subgroups by their respective outcomes (Skidmore, Rogers, Chandler, & Holm, 2006; SPSS Training Department, 2001). Use of the CHAID approach is appropriate in the exploratory study of predictors of patient-reported outcomes after rehabilitation (Chan, Cheing, Chan, Rosenthal, & Chronister, 2006; Huang et al., 2010).

To date, no study has used the SS-QOL to investigate the predictors of HRQOL outcome after CIT or dCIT. The purpose of this study was to identify the determinant factors contributing to change in stroke-specific QOL measured by the SS-QOL after dCIT among stroke survivors. The study results may facilitate the understanding of the relationship between client factors (i.e., age, side of lesion, ADLs) and HRQOL and assist in outcome predictions and treatment planning.

Method

Research Design

The research design involved decision analyses (i.e., CHAID) for one group, before and after the dCIT intervention. The research ethics committees of the participating sites approved the study, and all participants gave informed consent.

Participants

We obtained data from 74 participants enrolled in dCIT studies investigating the effects of UE motor rehabilitation

¹FIM™ is a trademark of the Uniform Data System for Medical Rehabilitation, a division of UB Foundation Activities, Inc.

therapy (Lin, Chang, et al., 2009; Wu et al., 2007). These patients, who were consecutively screened and recruited from four stroke rehabilitation units, completed the SS-QOL before and after the dCIT intervention.

The inclusion criteria were as follows: hemiplegia, first stroke and ≥ 1 mo after stroke onset, no cognitive deficiency (Mini-Mental State Examination [MMSE; Folstein, Folstein, & McHugh, 1975] score ≥ 23) and able to understand the questionnaires, voluntary movement (Brunnstrom stage >3) for the proximal part of the affected UE, and no excessive spasticity in the joints of the affected UE (Modified Ashworth Scale [Bohannon & Smith, 1987] score ≤ 2).

Instruments

We measured QOL outcomes with the SS-QOL (Williams, Weinberger, Harris, & Biller, 1999), a self-report assessment that includes 12 stroke-specific subscales with 49 items. The SS-QOL attempts to capture the domains of stroke-specific QOL that are insufficiently assessed with generic QOL measures. The 12 subscales, which are unidimensional, are Energy, Family Role, Language, Mobility, Mood, Personality, Self-Care, Social Roles, Thinking, Upper Extremity Function, Vision, and Work-Productivity. Participants responded to each item on a 5-point Likert scale. Domain scores are the averages of the item scores, and the total score is the average of the domain scores. All summary scores therefore range from 1 to 5. Higher scores indicate better function.

Reliability was established for each domain, with Cronbach's α s ranging from .73 to .89. Construct validity was established by correlating the SS-QOL scores to scores on the Short Form 36-Item Health Survey (Ware & Sherbourne, 1992), Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), National Institutes of Health Stroke Scale (Brott et al., 1989), and Barthel Index (Mahoney & Barthel, 1965) (r^2 s = .3–.5; Williams, Weinberger, Harris, Clark, & Biller, 1999). Validity (r s = .25–.88) and test-retest reliability (intra-class correlations [ICCs] = .53–.96) of the SS-QOL have been established in many cultures (Boosman, Passier, Visser-Meily, Rinkel, & Post, 2010; Ewert & Stucki, 2007; Lima et al., 2008; Lin et al., 2010; Muus et al., 2007).

Procedures

Occupational therapists screened patients, recruited eligible participants, and delivered the intervention to patients. Screening tests included a demographic survey and the MMSE. All clinical measures were administered to study participants by a blinded rater before and

immediately after the intervention. After pretesting, the therapists provided a 3-wk intervention for each participant.

Predictors. We identified eight potential determinants: age, gender, side of lesion, time since stroke, cognitive status (MMSE), motor impairment of the UE (Fugl-Meyer Assessment [FMA; Fugl-Meyer, Jääskö, Leyman, Olsson, & Steglind, 1975]), ADLs (FIM), and IADLs (Nottingham Extended Activities of Daily Living [NEADL] Scale; Green, Forster, & Young, 2001). We selected these predictors because the findings of previous studies and expert opinions indicated that they were important predictors of outcomes after rehabilitation or that they were highly related to QOL as described in the aforementioned research. We used the MMSE, which has good reliability and validity, to evaluate cognitive status (Elhan et al., 2005; Folstein et al., 1975). The FMA measured UE motor function. The FIM was used to evaluate basic ADL capabilities (Hamilton et al., 1994; Hamilton, Klein, Opat, & Timmins, 1987). The NEADL has 22 questions assessing Mobility, Kitchen, Domestic, and Leisure domains (Lincoln & Gladman, 1992) and is designed to measure IADL after stroke. It is suitable for studies evaluating outcome after stroke rehabilitation (Lincoln & Gladman, 1992).

Intervention. After the pretest assessment, participants received the dCIT intervention in occupational therapy sessions for 2 hr/day, 5 days/wk, for 3 wk. Five licensed occupational therapists trained in the study procedures and intervention protocols provided the treatments. The treatment activities involved functional tasks such as brushing hair or picking up a cup. The unaffected arm was restricted in a mitt 6 hr/day, 5 days/wk, for 3 wk.

Data Collection

Within 1 wk before and 1 wk after the 3-wk dCIT intervention, three blinded raters administered the four standardized measurements (FMA, FIM, NEADL, and SS-QOL). Approximately 1 hr was needed to finish these measurements. The raters were trained under the supervision of senior occupational therapists and followed the standardized written instructions that were provided by the study investigators. The interrater reliability between the raters of each SS-QOL domain was high (ICCs $\geq .84$).

Data Analysis

The sample used in this study included the participants who received the dCIT intervention. We used SPSS software (Version 19.0; IBM SPSS Statistics Inc., Chicago) for data entry and generation of descriptive statistics.

CHAID analysis was used to identify the predictors that were most strongly linked with each SS-QOL domain. The advantage of using CHAID is that it offers concrete information about the predictors. Therefore, we also used CHAID to further identify the best specific scores of the predictors that distinguished the SS-QOL domains. The α level for all statistical tests was .05.

Results

Table 1 presents the demographic and clinical characteristics of the 74 patients enrolled in this study (30% women, 70% men). Participants' average age was 57 yr, and the average time since stroke was 19 mo. The number of participants with left and right hemisphere lesions was about equal (49% and 51%, respectively). Table 2 presents the numbers of patients who improved, did not change, or deteriorated after dCIT in each SIS domain. Using CHAID analysis, we identified the factors predictive of outcome for 4 of the 12 SS-QOL domains. These 4 domains and their predictors are summarized next.

Table 1. Participants' Demographics and Clinical Characteristics (N = 74)

Characteristics	Value
Age, yr (mean $\pm$ SD)	57.15 $\pm$ 11.72
Gender, n (%)	
Female	22 (29.7)
Male	52 (70.3)
Side of stroke lesion, n (%)	
Left	36 (48.6)
Right	38 (51.4)
Months since stroke, mean (range)	18.85 (1.5–88)
Mini-Mental State Examination, mean $\pm$ SD	27.47 $\pm$ 2.28
Fugl-Meyer Assessment, mean $\pm$ SD	44.35 $\pm$ 12.67
FIM, mean $\pm$ SD	112.18 $\pm$ 21.56
NEADL scale, mean $\pm$ SD	28.81 $\pm$ 13.22
SS-QOL domain, mean $\pm$ SD	
Energy	3.37 $\pm$ 1.32
Family Role	2.93 $\pm$ 1.06
Language	4.12 $\pm$ 0.97
Mobility	4.34 $\pm$ 0.79
Mood	3.89 $\pm$ 1.34
Personality	3.01 $\pm$ 1.12
Self-Care	4.14 $\pm$ 0.75
Social Roles	2.76 $\pm$ 1.22
Thinking	3.79 $\pm$ 1.10
Upper Extremity Function	3.99 $\pm$ 0.73
Vision	4.74 $\pm$ 0.52
Work-Productivity	3.50 $\pm$ 0.87
Overall SS-QOL, mean $\pm$ SD	3.03 $\pm$ 0.39

Note. NEADL = Nottingham Extended Activities of Daily Living Scale; SD = standard deviation; SS-QOL = Stroke-Specific Quality of Life Scale.

Table 2. Number of Participants Who Improved, Did Not Change, or Deteriorated After Intervention in Each Domain of the SS-QOL Scale

SS-QOL Domain	Participant Outcome, n		
	Improved	No Change	Deteriorated
Energy	28	17	29
Family Role	25	21	28
Language	33	26	15
Mobility	28	25	21
Mood	27	14	33
Personality	38	17	19
Self-Care	31	22	21
Social Roles	35	10	29
Thinking	27	24	23
Upper-Extremity Function	33	13	28
Vision	15	50	9
Work-Productivity	25	21	28
Overall	47	2	25

Note. SS-QOL = Stroke-Specific Quality of Life Scale.

Energy Domain

Side of lesion was the indicator most strongly associated with Energy outcomes, separating the sample into two groups (Figure 1A). SS-QOL Energy domain scores improved significantly more among participants with a right-sided lesion than among those with a left-sided lesion. The subgroup with a right-sided lesion was further differentiated into two groups by the time since stroke: those who were >17 mo poststroke had more improvement than those who were <17 mo poststroke.

The misclassification risk estimate of the original sample on the SS-QOL Energy domain scores was .176. The average misclassification risk estimate of the validation samples was .240.

Family Roles Domain

Time since stroke was the indicator most strongly associated with Family Roles outcomes, separating the sample into two groups (Figure 1B). Family Roles domain scores improved significantly more among participants who were >10 mo poststroke than among participants who were $\leq$ 10 mo poststroke.

The misclassification risk estimate of the original sample on the SS-QOL Family Role scores was .139. The average misclassification risk estimate of the validation samples was .177.

Mobility Domain

NEADL score was the indicator most strongly associated with mobility outcomes in the SS-QOL Mobility domain scores, separating the sample into two groups

Figure 1. Chi-square automatic interaction detector diagram showing the factors predictive of outcomes for four domains of the Stroke-Specific Quality of Life Scale (A) Energy; (B) Family Roles; (C) Mobility, according to the NEADL scale; and (D) Mood, according to the NEADL scale.

Note. The means and standard deviations in the nodes indicate relative change scores of the respective sample. NEADL = Nottingham Extended Activities of Daily Living Scale; *SD* = standard deviation.

(Figure 1C). Participants with NEADL scores of ≤ 11 improved significantly more than those whose scores were > 11 .

The misclassification risk estimate of the original sample on the SS-QOL Mobility scores was .106. The average misclassification risk estimate of the validation samples was .139.

Mood Domain

Age was the indicator most strongly associated with Mood domain outcomes, separating the sample into two groups

(Figure 1D). Participants > 68 yr old showed significantly greater improvement in SS-QOL Mood domain scores than did participants ≤ 68 yr old. Those ≤ 68 yr old were further differentiated by their NEADL scores into two subgroups. Patients whose NEADL scores were > 20 had a better outcome than those whose NEADL scores were ≤ 20 .

The misclassification risk estimate of the original sample on the SS-QOL Mood scores was .065. The average misclassification risk estimate of the validation samples was .095.

Discussion

This study is the first to determine predictors of SS-QOL outcomes for participants receiving dCIT. A previous study found only one predictor of SIS outcome (Huang et al., 2010), whereas we found four predictors of SS-QOL outcome after dCIT. The SS-QOL is a comprehensive and multidimensional HRQOL scale that focuses less on the physical dimensions by assessing additional multidimensional domains, such as Energy and Family Role, that are not covered by the SIS scale. This more comprehensive range of QOL domains could explain why more predictors were found in our study than in the previous study. The four predictors of SS-QOL outcome after dCIT determined by this study are side of lesion, time since stroke, IADL performance, and age.

Effect of Side of Stroke on the SS-QOL Energy Domain

SS-QOL Energy domain scores improved significantly more among participants with a right-sided brain lesion (left hemiparesis) than among those with a left-sided brain lesion (right hemiparesis). This result is similar to those of Byl et al. (2003), who found that stroke survivors with right-sided brain damage had advantages after functional independence training. Because 70 participants in our study were right-handed, those with a right-sided brain lesion exhibited deficits in the non-dominant (left) hand. After dCIT, the left hand could assist the right dominant hand, and participants performed tasks without a strong feeling of being tired. People with a left-sided brain lesion, however, may require the affected right-dominant hand, which is primarily responsible for activity performance, to expend great effort in doing complicated activities. Therefore, even though the affected right-dominant hand showed some improvement after dCIT, stroke survivors still felt exhausted and frustrated when engaging in activities using the affected right-dominant hand.

Participants in the right-sided lesion subgroups were further differentiated into two groups by time since stroke. Patients who were >17 mo poststroke experienced more improvement in the SS-QOL Energy domain than those who were <17 mo poststroke. One study showed that 52% of patients with disabling ischemic stroke recovered within 18 mo (Hankey et al., 2007). Stroke patients with onset >17 mo ago may have recovered maximally and did not need to spend a lot of time in bed, nor did they feel tired in performing daily life activities. These changes in recovery as a result of dCIT were reflected in self-perceived energy consumption for task performance.

Influence of Time Since Stroke on the SS-QOL Family Role Domain

Family Role domain scores improved significantly more among participants who were >10 mo poststroke than among those ≤10 mo poststroke. Patients with onset >10 mo ago have usually received a period of standard rehabilitation treatment, and the opportunity for spontaneous recovery to occur is attenuated (Wolf et al., 2006). Neurologic status and motor reorganization might tend to be more stable after 10 mo. Participants with onset >10 mo ago might have better capacity after receiving dCIT to apply these learned motor skills to daily life and family life than patients with onset <10 mo ago; therefore, they will have greater opportunities to engage in a family role.

Effect of IADLs on the SS-QOL Mobility Domain

Participants with NEADL scores of ≤11 of the total 22 points improved significantly more in SS-QOL Mobility domain scores than those with NEADL scores >11 points. This finding suggests that stroke patients with lower capabilities in extended ADL performance before treatment had more room to improve than those who had higher capabilities in extended ADL performance before treatment. The four NEADL domains are Mobility, Kitchen, Domestic, and Leisure. The NEADL Mobility domain, along with some other NEADL domains, is related to the SS-QOL Mobility domain, resulting in the NEADL being a significant predictor for the Mobility outcome on the SS-QOL.

Evidence Regarding Age and IADLs on the SS-QOL Mood Domain

SS-QOL Mood domain scores improved significantly more among participants who were >68 yr old than among those ≤68 yr old. Older age is related to increasing subjective well-being among stroke patients (Wyller, Holmen, Laake, & Laake, 1998). People who are >68 yr old may have fewer expectations for potential improvement from dCIT; if true, they may be more easily satisfied with improvement after dCIT than younger people.

However, people who were <68 yr old and had lower IADL abilities (NEADL scores <20) were located in the unfavorable outcome end of the SS-QOL Mood domain, indicating that these two risk factors deteriorated mood outcome after the intervention. The explanation might be that stroke survivors who are <68 yr old might have more desire and expectations for performing IADLs. Poor IADL ability (NEADL score <20) may have impeded them from achieving their expectations, even after

training, thus negatively affecting their mood outcome. This study lends support to the findings of previous studies that IADL is related to HRQOL and life satisfaction (Hartman-Macir et al., 2007; Sveen et al., 2004).

Gender, cognitive status (as measured by the MMSE), motor ability (as measured by the FMA), and daily functional ability (as measured by the FIM) did not appear to be predictors of SS-QOL scores in this study sample. Our findings were consistent with those of a previous study (Jönsson, Lindgren, Hallström, Norrving, & Lindgren, 2005) that showed that gender and levels of cognitive and motor function were not determinants of any changes in the HRQOL domains. An unexpected finding was that change in FIM scores was not significantly related to change in SS-QOL scores. Use of different potential predictors and measurement tools for HRQOL outcome (e.g., the SS-QOL and SIS) in the research literature might account for this discrepancy. Unlike the SIS, the SS-QOL involves Energy, Family Role, Social Role, and Work-Productivity domains, which may be closely related to IADL and which the FIM is not sensitive in detecting. The SIS and SS-QOL both contain the ADL-IADL domain; however, this domain in the SIS includes some items, such as bladder and bowel control, that are more specific and basic than items on the SS-QOL. The FIM might better predict the basic ADL items on the SIS than the general and complex ones on the SS-QOL.

Even though the SS-QOL scores improved after treatment, the eight predictors that we tested only predicted 4 of the 12 domains. No specific predictors were identified in the SS-QOL domains of Language, Personality, Self-Care, Social Roles, Thinking, Upper Extremity Function, Vision, and Work-Productivity. Contrary to our intuition, we found no significant predictors for the Upper Extremity Function, Self-Care, and Work-Productivity domains. These three domains involve increasingly complicated physical activities that require finer motor control and bilateral arm movement. A close examination of the items in the SS-QOL Upper Extremity Function domain suggested that the questions related to daily functional tasks, such as "Did you have trouble putting on socks?" or "Did you have trouble opening a jar?" may require bilateral arm function. The dCIT regimen focuses on mass practice of the affected arm, and the possible benefits of motor ability after dCIT may not have translated into self-perceived improvement in functional tasks performed with both arms. In addition, participants were close to age 60, and returning to work may not have been a primary goal for rehabilitation, resulting in no notable improvement in the Work-Productivity domain.

Implications for Occupational Therapy Practice

This study provides information for health professionals about which client factors are relevant for predicting HRQOL outcomes after dCIT. Because dCIT is an intensive treatment that requires careful patient selection, knowing the factors predictive of how well a patient might benefit from dCIT is important. If confirmed, this study's findings may also inform referral criteria and insurance reimbursement. The findings can be used to plan interventions and set treatment goals for stroke survivors. For example, an occupational therapist who knows that a patient meets the criteria for admission to dCIT and has NEADL scores <11 may expect that the patient holds promise for improvement in mobility after dCIT, because the findings of this exploratory study showed that the SS-QOL Mobility domain scores improved significantly more among stroke patients with NEADL scores of <11 than among stroke patients with NEADL scores >11. Moreover, occupational therapists may expect greater improvement in the Energy domain after dCIT among patients with right-side lesions and onset >17 mo earlier. Onset >10 mo ago and age >68 yr predicted improvement in the Family Role and Mood domains, respectively. Given the exploratory nature of this CHAID analysis, a need exists for further occupational therapy research to test for robustness of the predictive models.

In summary, this research has the following implications for occupational therapy practice and research:

- Side of lesion, time since stroke, IADL performance, and age are important determinants of change in HRQOL. This study showed that these four predictors of SS-QOL warrant consideration when implementing stroke rehabilitation programs such as dCIT.
- CHAID analysis is a useful method for exploring predictors of change in HRQOL after stroke rehabilitation.

Limitations and Future Research

This study has two limitations that warrant consideration. First, the results were obtained from higher level stroke survivors receiving dCIT. The findings may not be generalizable beyond the context of this study. Second, not all potentially relevant determinants, such as caregiver factors, were studied in this research. Awareness of the importance of caregivers for the long-term care of stroke survivors has been growing (Bugge, Alexander, & Hagen, 1999; Haley et al., 2009; Han & Haley, 1999; Jönsson et al., 2005; McCullagh, Brigstocke, Donaldson, & Kalra, 2005). Stroke studies have emphasized the need to consider the

patient's QOL as well as that of the caregiver (Jönsson et al., 2005; McCullagh et al., 2005). More expanded research is recommended to include caregiver factors, such as age, strain, and QOL, as potential determinants of stroke survivors' HRQOL.

Conclusion

The findings inform occupational therapists about the factors that may predict how well a participant will respond to dCIT and can also be used to create suitable treatment plans and goals for stroke patients. Future research may include factors such as caregiver characteristics, family support, and pre-morbid lifestyle as potential predictors of QOL outcomes after dCIT and after other regimens of stroke rehabilitation. ▲

Acknowledgments

This project was supported in part by the National Science Council (NSC 99-2314-B-182-014-MY3, NSC 100-2314-B-002-008-MY3, and NSC 100-2811-B-002-131), the National Health Research Institutes (NHRI-EX100-10010PI and NHRI-EX100-9920PI), and the Healthy Aging Research Center at Chang Gung University (EMRPD1A0891), Taoyuan, Taiwan.

References

- Algurén, B., Fridlund, B., Cieza, A., Sunnerhagen, K. S., & Christensson, L. (2012). Factors associated with health-related quality of life after stroke: A 1-year prospective cohort study. *Neurorehabilitation and Neural Repair*, 26, 266–274. <http://dx.doi.org/10.1177/1545968311414204>
- American Occupational Therapy Association. (2008). Occupational therapy practice framework: Domain and process (2nd ed.). *American Journal of Occupational Therapy*, 62, 625–683. <http://dx.doi.org/10.5014/ajot.62.6.625>
- Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, 4, 561–571. <http://dx.doi.org/10.1001%2Farchpsyc.1961.01710120031004>
- Boake, C., Noser, E. A., Ro, T., Baraniuk, S., Gaber, M., Johnson, R., . . . Levin, H. S. (2007). Constraint-induced movement therapy during early stroke rehabilitation. *Neurorehabilitation and Neural Repair*, 21, 14–24. <http://dx.doi.org/10.1177/1545968306291858>
- Bohannon, R., & Smith, M. (1987). Interrater reliability of a modified Ashworth Scale of muscle spasticity. *Physical Therapy*, 67, 206–207. <http://dx.doi.org/10.1080/02699050903200548>
- Boosman, H., Passier, P. E., Visser-Meily, J. M., Rinkel, G. J., & Post, M. W. (2010). Validation of the Stroke Specific Quality of Life scale in patients with aneurysmal subarachnoid haemorrhage. *Journal of Neurology, Neurosurgery, and Psychiatry*, 81, 485–489. <http://dx.doi.org/10.1136/jnnp.2009.184960>
- Brott, T., Adams, H. P., Jr., Olinger, C. P., Marler, J. R., Barsan, W. G., Biller, J., . . . Walker, M. (1989). Measurement of acute cerebral infarction: A clinical examination scale. *Stroke*, 20, 864–870. <http://dx.doi.org/10.1161%2F01.STR.20.7.864>
- Bugge, C., Alexander, H., & Hagen, S. (1999). Stroke patients' informal caregivers: Patient, caregiver, and service factors that affect caregiver strain. *Stroke*, 30, 1517–1523. <http://dx.doi.org/10.1161/01.STR.30.8.1517>
- Byl, N., Roderick, J., Mohamed, O., Hanny, M., Kotler, J., Smith, A., . . . Abrams, G. (2003). Effectiveness of sensory and motor rehabilitation of the upper limb following the principles of neuroplasticity: Patients stable poststroke. *Neurorehabilitation and Neural Repair*, 17, 176–191. <http://dx.doi.org/10.1177/0888439003257137>
- Chan, F., Cheing, G., Chan, J. Y., Rosenthal, D. A., & Chronister, J. (2006). Predicting employment outcomes of rehabilitation clients with orthopedic disabilities: A CHAID analysis. *Disability and Rehabilitation*, 28, 257–270. <http://dx.doi.org/10.1080/09638280500158307>
- Coster, W., Haley, S. M., Jette, A., Tao, W., & Siebens, H. (2007). Predictors of basic and instrumental activities of daily living performance in persons receiving rehabilitation services. *Archives of Physical Medicine and Rehabilitation*, 88, 928–935. <http://dx.doi.org/10.1016/j.apmr.2007.03.037>
- Dettmers, C., Teske, U., Hamzei, F., Uswatte, G., Taub, E., & Weiller, C. (2005). Distributed form of constraint-induced movement therapy improves functional outcome and quality of life after stroke. *Archives of Physical Medicine and Rehabilitation*, 86, 204–209. <http://dx.doi.org/10.1016/j.apmr.2004.05.007>
- Elhan, A. H., Kutlay, S., Küçükdeveci, A. A., Cotuk, C., Öztürk, G., Tesio, L., & Tennant, A. (2005). Psychometric properties of the Mini-Mental State Examination in patients with acquired brain injury in Turkey. *Journal of Rehabilitation Medicine*, 37, 306–311. <http://dx.doi.org/10.1080/16501970510037573>
- Ewert, T., & Stucki, G. (2007). Validity of the SS-QOL in Germany and in survivors of hemorrhagic or ischemic stroke. *Neurorehabilitation and Neural Repair*, 21, 161–168. <http://dx.doi.org/10.1177/1545968306292255>
- Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-Mental State": A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12, 189–198. [http://dx.doi.org/10.1016/0022-3956\(75\)90026-6](http://dx.doi.org/10.1016/0022-3956(75)90026-6)
- Fugl-Meyer, A. R., Jääskö, L., Leyman, I., Olsson, S., & Steglind, S. (1975). The post-stroke hemiplegic patient: 1. A method for evaluation of physical performance. *Scandinavian Journal of Rehabilitation Medicine*, 7, 13–31.
- Garcia, P., & McCarthy, M. (2000). *Measuring health: A step in the development of city health profiles*. Copenhagen: World Health Organization, Regional Office for Europe.
- Green, J., Forster, A., & Young, J. (2001). A test-retest reliability study of the Barthel Index, the Rivermead Mobility Index, the Nottingham Extended Activities of Daily Living Scale and the Frenchay Activities Index in stroke patients. *Disability and Rehabilitation*, 23, 670–676. <http://dx.doi.org/10.1080/09638280110045382>

- Haley, W. E., Allen, J. Y., Grant, J. S., Clay, O. J., Perkins, M., & Roth, D. L. (2009). Problems and benefits reported by stroke family caregivers: Results from a prospective epidemiological study. *Stroke*, 40, 2129–2133. <http://dx.doi.org/10.1161/STROKEAHA.108.545269>
- Hamilton, W. A., Butler, P. D., Baker, S. M., Smith, G. S., Hayter, J. B., Magid, L. J., & Pynn, R. (1994). Shear induced hexagonal ordering observed in an ionic viscoelastic fluid in flow past a surface. *Physical Review Letters*, 72, 2219–2222. <http://dx.doi.org/10.1103/PhysRevLett.72.2219>
- Hamilton, W. A., Klein, A. G., Opat, G. I., & Timmins, P. A. (1987). Neutron diffraction by surface acoustic waves. *Physical Review Letters*, 58, 2770–2773. <http://dx.doi.org/10.1103/PhysRevLett.58.2770>
- Han, B., & Haley, W. E. (1999). Family caregiving for patients with stroke: Review and analysis. *Stroke*, 30, 1478–1485. <http://dx.doi.org/10.1161/01.STR.30.7.1478>
- Hankey, G. J., Spiesser, J., Hakimi, Z., Bego, G., Carita, P., & Gabriel, S. (2007). Rate, degree, and predictors of recovery from disability following ischemic stroke. *Neurology*, 68, 1583–1587. <http://dx.doi.org/10.1212/01.wnl.0000260967.77422.97>
- Hartman-Maeir, A., Soroker, N., Ring, H., Avni, N., & Katz, N. (2007). Activities, participation and satisfaction one-year post stroke. *Disability and Rehabilitation*, 29, 559–566. <http://dx.doi.org/10.1080/09638280600924996>
- Hilari, K., Byng, S., Lamping, D. L., & Smith, S. C. (2003). Stroke and Aphasia Quality of Life Scale–39 (SAQOL–39): Evaluation of acceptability, reliability, and validity. *Stroke*, 34, 1944–1950. <http://dx.doi.org/10.1161/01.STR.0000081987.46660.ED>
- Huang, Y.-H., Wu, C.-Y., Hsieh, Y.-W., & Lin, K.-C. (2010). Predictors of change in quality of life after distributed constraint-induced therapy in patients with chronic stroke. *Neurorehabilitation and Neural Repair*, 24, 559–566. <http://dx.doi.org/10.1177/1545968309358074>
- Jönsson, A. C., Lindgren, I., Hallström, B., Norrving, B., & Lindgren, A. (2005). Determinants of quality of life in stroke survivors and their informal caregivers. *Stroke*, 36, 803–808. <http://dx.doi.org/10.1161/01.STR.0000160873.32791.20>
- Kass, G. (1980). An exploratory technique for investigating large quantities of categorical data. *Applied Statistics*, 29, 119–127. <http://dx.doi.org/10.2307/2986296>
- Kissela, B. (2006). The value of quality of life research in stroke. *Stroke*, 37, 1958–1959. <http://dx.doi.org/10.1161/01.STR.0000234047.57744.d9>
- Lima, R. C. M., Teixeira-Salmela, L. F., Magalhães, L. C., & Gomes-Neto, M. (2008). Psychometric properties of the Brazilian version of the Stroke-Specific Quality of Life scale: Application of the Rasch model. *Brazilian Journal of Physical Therapy*, 12, 149–156.
- Lin, K.-C., Chang, Y.-F., Wu, C.-Y., & Chen, Y.-A. (2009). Effects of constraint-induced therapy versus bilateral arm training on motor performance, daily functions, and quality of life in stroke survivors. *Neurorehabilitation and Neural Repair*, 23, 441–448. <http://dx.doi.org/10.1177/1545968308328719>
- Lin, K.-C., Fu, T., Wu, C.-Y., Hsieh, Y.-W., Chen, C.-L., & Lee, P.-C. (2010). Psychometric comparisons of the Stroke Impact Scale 3.0 and Stroke-Specific Quality of Life Scale. *Quality of Life Research*, 19, 435–443. <http://dx.doi.org/10.1007/s11136-010-9597-5>
- Lin, K.-C., Huang, Y.-H., Hsieh, Y.-W., & Wu, C.-Y. (2009). Potential predictors of motor and functional outcomes after distributed constraint-induced therapy for patients with stroke. *Neurorehabilitation and Neural Repair*, 23, 336–342. <http://dx.doi.org/10.1177/1545968308321773>
- Lin, K.-C., Wu, C.-Y., Liu, J.-S., Chen, Y.-T., & Hsu, C.-J. (2009). Constraint-induced therapy versus dose-matched control intervention to improve motor ability, basic/extended daily functions, and quality of life in stroke. *Neurorehabilitation and Neural Repair*, 23, 160–165. <http://dx.doi.org/10.1177/1545968308320642>
- Lin, K.-C., Wu, C.-Y., Wei, T.-H., Gung, C., Lee, C.-Y., & Liu, J.-S. (2007). Effects of modified constraint-induced movement therapy on reach-to-grasp movements and functional performance after chronic stroke: A randomized controlled study. *Clinical Rehabilitation*, 21, 1075–1086. <http://dx.doi.org/10.1177/0269215507079843>
- Lincoln, N. B., & Gladman, J. R. (1992). The Extended Activities of Daily Living Scale: A further validation. *Disability and Rehabilitation*, 14, 41–43. <http://dx.doi.org/10.3109/09638289209166426>
- Mahoney, F. D., & Barthel, D. W. (1965). Functional evaluation: The Barthel Index. *Maryland State Medical Journal*, 14, 61–63.
- McCullagh, E., Brigstocke, G., Donaldson, N., & Kalra, L. (2005). Determinants of caregiving burden and quality of life in caregivers of stroke patients. *Stroke*, 36, 2181–2186. <http://dx.doi.org/10.1161/01.STR.0000181755.23914.53>
- Muus, I., Williams, L. S., & Ringsberg, K. C. (2007). Validation of the Stroke-Specific Quality of Life Scale (SS-QOL): Test of reliability and validity of the Danish version (SS-QOL-DK). *Clinical Rehabilitation*, 21, 620–627. <http://dx.doi.org/10.1177/0269215507075504>
- Rijntjes, M., Hobbeling, V., Hamzei, F., Dohse, S., Ketels, G., Liepert, J., & Weiller, C. (2005). Individual factors in constraint-induced movement therapy after stroke. *Neurorehabilitation and Neural Repair*, 19, 238–249. <http://dx.doi.org/10.1177/1545968305279205>
- Rowe, V. T., Blanton, S., & Wolf, S. L. (2009). Long-term follow-up after constraint-induced therapy: A case report of a chronic stroke survivor. *American Journal of Occupational Therapy*, 63, 317–322. <http://dx.doi.org/10.5014/ajot.63.3.317>
- Salter, K. L., Moses, M. B., Foley, N. C., & Teasell, R. W. (2008). Health-related quality of life after stroke: What are we measuring? *International Journal of Rehabilitation Research*, 31, 111–117. <http://dx.doi.org/10.1097/MRR.0b013e3282fc0f33>
- Schmid, A. A., Acuff, M., Doster, K., Gwaltney-Duizer, A., Whitaker, A., Damash, T., . . . Hendrie, H. (2009). Post-stroke fear of falling in the hospital setting. *Topics in Stroke Rehabilitation*, 16, 357–366. <http://dx.doi.org/10.1310/tsr1605-357>
- Skidmore, E. R., Rogers, J. C., Chandler, L. S., & Holm, M. B. (2006). Dynamic interactions between impairment and activity after stroke: Examining the utility of decision

- analysis methods. *Clinical Rehabilitation*, 20, 523–535. <http://dx.doi.org/10.1191/0269215506cr980oa>
- SPSS Training Department. (2001). *SPSS Answer Tree 3.0 training manual*. Chicago: SPSS Inc.
- Sunderland, A., & Tuke, A. (2005). Neuroplasticity, learning and recovery after stroke: A critical evaluation of constraint-induced therapy. *Neuropsychological Rehabilitation*, 15, 81–96. <http://dx.doi.org/10.1080/09602010443000047>
- Sveen, U., Thommessen, B., Bautz-Holter, E., Wyller, T. B., & Laake, K. (2004). Well-being and instrumental activities of daily living after stroke. *Clinical Rehabilitation*, 18, 267–274. <http://dx.doi.org/10.1191/0269215504cr719oa>
- Teixeira-Salmela, L. F., Neto, M. G., Magalhães, L. C., Lima, R. C., & Faria, C. D. C. M. (2009). Content comparisons of stroke-specific quality of life based upon the *International Classification of Functioning, Disability and Health. Quality of Life Research*, 18, 765–773. <http://dx.doi.org/10.1007/s11136-009-9488-9>
- Uniform Data System for Medical Rehabilitation. (1997). *Guide for the Uniform Data Set for Medical Rehabilitation (including the FIM™ instrument), version 5.1*. Buffalo, NY: Author.
- Vrdoljak, D., & Rumboldt, M. (2008). Quality of life after stroke in Croatian patients. *Collegium Antropologicum*, 32, 355–359.
- Ware, J. E., & Sherbourne, C. D. (1992). The MOS 36-item short form health survey (SF-36), I: Conceptual framework and item selection. *Medical Care*, 30, 472–483. <http://dx.doi.org/10.1097%2F00005650-199206000-00002>
- Williams, L. S., Weinberger, M., Harris, L. E., & Biller, J. (1999). Measuring quality of life in a way that is meaningful to stroke patients. *Neurology*, 53, 1839–1843. <http://dx.doi.org/10.1212/WNL.53.8.1839>
- Williams, L. S., Weinberger, M., Harris, L. E., Clark, D. O., & Biller, J. (1999). Development of a stroke-specific quality of life scale. *Stroke*, 30, 1362–1369. <http://dx.doi.org/10.1161/01.STR.30.7.1362>
- Wolf, S. L., Winstein, C. J., Miller, J. P., Taub, E., Uswatte, G., Morris, D., . . . Nichols-Larsen, D.; EXCITE Investigators. (2006). Effect of constraint-induced movement therapy on upper extremity function 3 to 9 months after stroke: The EXCITE randomized clinical trial. *JAMA*, 296, 2095–2104. <http://dx.doi.org/10.1001/jama.296.17.2095>
- Wu, C. Y., Chen, Y. A., Chen, H. C., Lin, K. C., & Yeh, I. L. (2012). Pilot trial of distributed constraint-induced therapy with trunk restraint to improve poststroke reach to grasp and trunk kinematics. *Neurorehabilitation and Neural Repair*, 26, 247–255. <http://dx.doi.org/10.1177/1545968311415862>
- Wu, C. Y., Chen, C. L., Tsai, W. C., Lin, K. C., & Chou, S. H. (2007). A randomized, controlled trial of modified constraint-induced movement therapy for elderly stroke survivors: Changes in motor impairment, daily functioning, and quality of life. *Archives of Physical Medicine and Rehabilitation*, 88, 273–278. <http://dx.doi.org/10.1016/j.apmr.2006.11.021>
- Wyller, T. B., Holmen, J., Laake, P., & Laake, K. (1998). Correlates of subjective well-being in stroke patients. *Stroke*, 29, 363–367. <http://dx.doi.org/10.1161/01.STR.29.2.363>