Depression and Other Determinants of Values Placed on Current Health State by Stroke Patients
Evidence From the VA Acute Stroke (VASt) Study

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Background and Purpose—This prospective study examined the determinants of the utility (value) placed on health status among a sample of patients with acute ischemic and intracerebral hemorrhagic stroke. Decision theory indicates that when utility for relevant health states is assessed in terms of willingness to make tradeoffs to avoid those states, then the predicted average utility resulting from a particular intervention is a meaningful guide to the overall value of that intervention. However, little is known empirically about the determinants of health status utility and, hence, its meaning and generalizability. To date, health status utility scores for various stroke practices have been derived from patients at risk for future major stroke (eg, see References 2 to 5) and from patients who have never experienced stroke (eg, see References 3 to 6). As might be anticipated, these factors need to be considered when conducting stroke decision analyses if more accurate conclusions are to be drawn regarding preferred patterns of care. (Stroke. 2000;31:2603-2609.)

Key Words: depression ■ physical function ■ quality of life ■ stroke outcome

The utility (value) placed by a patient on his or her current physical health state is a key concept in health outcome assessment of stroke, especially for disease policy modeling. Decision theory indicates that when utility for relevant health states is assessed in terms of willingness to make tradeoffs to avoid those states, then the predicted average utility resulting from a particular intervention is a meaningful guide to the overall value of that intervention. However, little is known empirically about the determinants of health status utility and, hence, its meaning and generalizability. To date, health status utility scores for various stroke practices have been derived from patients at risk for future major stroke (eg, see References 2 to 5) and from patients who have never experienced stroke (eg, see References 3 to 6). As might be anticipated, such patients respond with low health status utilities for severe physical impairments. Yet, it is clear that patients who actually experience a high level of impairment give a high utility score to their current health state (eg, see Reference 7).

A number of factors beyond the actual level of physical functioning may modify the true utility score that patients have for their state of health. One potentially important factor is time. It may be that as the stroke patient recovers or adapts to a given level of physical function, the associated health status utility score may increase. If health status utility varies with time, the point at which the utility is solicited could greatly affect the “optimal” treatment strategy identified.

Other potentially modifying factors include psychological health status and the individual’s living environment, particularly the availability of social support. Health status utility may be especially sensitive to depression, decreasing with the
onset of depression. Depression is common among survivors of stroke; it affects up to one third of patients even as late as 3 years after the event.\(^8\)–\(^10\) Health status utility may also change with the amount of social support received or perceived, either for the short or longer term.\(^11\)–\(^13\)

Using data from a 9-site prospective cohort study of stroke patients who were clinically managed at Department of Veterans Affairs (VA) Medical Centers, we were able to assess the relative importance of psychological health (and social environment) vis-à-vis physical function as independent determinants of patients’ evaluations of their current health states. We were also able to explore the stability of stroke patient health status utilities over the initial year after stroke.

### Subjects and Methods

#### Study Design

The present study is a secondary analysis that uses data from the VA Acute Stroke (VASt) study, which involved a prospective cohort of 1073 patients who were hospitalized for acute stroke at any of 9 VA hospitals between April 1995 and March 1997.\(^14\) The VASt study followed patients from presentation through 1 year after stroke onset. Data were obtained on key acute care diagnostic and therapeutic procedures that were used and on a broad array of physical and psychological health outcomes. Data on in-hospital care came from medical record review, and outcome data came from telephone interviews that were conducted at 1, 6, and 12 months after admission. The institutional review board at each participating site approved the VASt study protocols.

#### Patient Population

The patients represent a virtually complete census of patients with acute ischemic and intracerebral hemorrhagic stroke seen at these sites during the study period. Patients were eligible for the present study if they had a confirmed diagnosis of intracerebral hemorrhage (International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] 431) or cerebral infarct (ICD-9-CM 434 and 436). Patients were excluded if the stroke was iatrogenic, secondary to either brain tumor or trauma, occurred during hospitalization for another condition, was an extension of a previous stroke, or had an onset \(\geq 7\) days before the admission. Patients with a previous stroke were included in the cohort unless the stroke leading to the admission was an extension of the initial stroke.

#### Data Collection

A research assistant at each site identified potentially eligible patients within 48 hours of admission by reviewing the hospital’s admission logbook for patients admitted with symptoms suggestive of stroke. The diagnosis was initially confirmed by review of the medical record and, when necessary, discussion with the attending physician. To ensure that no stroke patient was missed, the computerized discharge files of each hospital were screened for patients discharged with a diagnosis of intracerebral hemorrhage or acute cerebral infarct. Approximately 11% of the patients were identified in this manner. A final review of the medical record was conducted to confirm that all eligibility criteria were met. Eligible patients were enrolled as soon after identification as possible; for the majority of patients, this occurred in the hospital, but for some, it was at the first interview.

All telephone interviews were performed from a central site by one interviewer who was experienced in interviewing severely ill patients. Follow-up data were available for 881 (82%) of the 1073 patients. For the present study, because of our emphasis on psychological health outcomes, we restricted the cohort to those patients who did not require a proxy respondent (ie, those were able to understand and communicate with the interviewer or were not cognitively impaired, as determined by the Short Portable Mental Status Questionnaire.\(^1\) A cognitive screening test). Proxy information was not included in the present study because proxies were not considered capable of providing valid responses to such psychological health measures as preference for current health state or depressive symptoms. Compared with those patients who did not require proxy informants, patients who required proxy informants had lower levels of physical function as measured by the Barthel Index and were more likely to have been institutionalized.\(^2\) We further restricted the cohort to those patients who participated in at least 2 of the 3 follow-up interviews because we were interested in examining changes in patients’ current health perceptions. Patients who had \(\geq 2\) follow-up interviews did not differ significantly from those patients who had a single interview in terms of demographic factors, stroke severity, or clinical care received (data available from the authors on request). Our final sample was composed of 327 patients.

#### Outcome

Our outcome was patient health status utility, which was measured by the time-tradeoff method.\(^3\) This generic measure of utility is based on the patient’s willingness to trade hypothetical years of life in the current health state to live in excellent health. We used the standard approach that involved a 10-year base for current health state with the trade being 1-year decrements (with subdecrements of 6 and 3 months) in excellent health until the patient reached a point where he or she was indifferent to the trade. The final utility score can range from 0.25 to 9.75, with lower scores indicating lower valuation of current health state, ie, a willingness to trade more years of life to avoid the current health state.\(^4\)

#### Primary Explanatory Variables

The factors of primary interest included time, social environment, physical function and, especially, depressive symptomatology. Because of the nature of the cohort, to minimize patient burden, an abbreviated version of the depression scale of the Center for Epidemiologic Studies (CES-D scale) was used to solicit symptoms of clinical depression.\(^5\) The abbreviated CES-D scale is based on the full CES-D scale,\(^6\) which is a 20-item self-report scale designed to measure depressive symptomatology in a general population. The questions refer to symptoms experienced during the week before the interview. We classified patients as positive for depressive disorder (1 indicating yes; 0, no) if they scored \(\geq 0.06\) on the scale.\(^7\) Analyses of data from a general population, primary care patients, and mental health patients \((n = 3000)\) showed that the measure with a cutoff of 0.06 had a high sensitivity (89%) and positive predictive value for detecting depressive disorder (specificity 95%) in the past month, especially for those that met full criteria for depression as assessed by Diagnose and Statistical Manual of Mental Disorders, edition 3.\(^8\)

Physical function was assessed by the patient’s ability to perform activities of daily living as measured by the Barthel Index.\(^9\) This 10-item scale has a self-care component that includes questions on eating, grooming, and toilet capabilities and a mobility component with items involving ability to transfer and ambulation. Scores range from 0 to 100, with higher scores signifying better functioning. Interrater reliability is high \((r = 0.99)\) when used with stroke patients.\(^10\)

Social environment was measured by living situation and marital status. Social environment is known to influence recovery from stroke.\(^11\) It was divided into 3 categories: living with someone, living alone, or being institutionalized at the time of discharge. For analytic purposes, living with someone was used as the referent category.

#### Covariates

Covariates were selected on the basis of a theoretical or empirically documented association with patient health status utility.

Demographic information included age, race, sex, and education.

Stroke severity, a major determinant of residual physical and, perhaps, psychological impairment, was measured by the modified Canadian Neurological Scale.\(^12\) The original scale was modified for...
retrospective ascertainment of severity by use of medical record data. The modified scale is a valid and reliable instrument; for this data set, the intrarater and interrater reliability were high, with a weighted $k$ value of 0.77 and 0.79, respectively. Scores range from 0 to 11.5, with lower scores indicating greater severity.

Stroke type was classified as either hemorrhagic stroke (ICD-9-CM 431) or ischemic stroke (ICD-9-CM 434, 436). There is evidence indicating that stroke type may be related to “vascular depression” and, subsequently, may influence patient health status utility.

Level of care was assessed by considering whether neurologists or other specialists, particularly internists, managed the stroke patient. Current evidence suggests that neurologists select patients who have a better prognosis on the basis of clinical characteristics. Thus, this variable “captures” those clinical characteristics that influence health outcomes and, therefore, are likely to be associated with health status utility measurements.

### Data Analysis

Because of our primary interest in the role of depression, the analysis was oriented toward understanding the modifying effect of depression on patient health status utility. We first examined whether individuals identified as being depressed differed from nondepressed patients at baseline in terms of key characteristics. To assess differences, we used the $\chi^2$ statistic for categorical variables and ANOVA for continuous variables. The stability of the patient health status utility over time and the relationship between patient health status utility, depression, and physical function were assessed by Pearson correlation coefficients.

To determine the independent effect of depression on patient health status utility, we used a general linear mixed-effects model to estimate the association between patient utility and depression, adjusting for social environment, physical function, and covariates over the 1-year period. The mixed model is able to explicitly determine associations and tests of hypotheses about population parameters (fixed effects) while simultaneously determining associations and tests of hypotheses about patient-specific parameters (random effects).

For the initial specification of the model, we included the following: linear time and quadratic time; the demographic characteristics of age (continuous), race (African American versus white), and education ($<$12 years, 12 years, and $>$13 years of education); level of care (neurologist versus other specialist); severity of stroke (continuous); stroke type (ischemic versus hemorrhagic); social environment, as indicated by living situation (living with someone, living alone, or institutionalized) and marital status (married versus otherwise); physical function via the Barthel index (continuous); and the presence of depression (depressed versus not depressed). Depression was considered a static variable, indicating patient depression at $\geq 1$ follow-up contacts.

Because of the number of variables, the initial mixed model used only main effects (ie, no interactions). To obtain the most parsimonious model, our model reduction procedure involved a backward selection, removing one variable at a time on the basis of the size of the $P$ value. As a covariate was removed, the model was refitted with the remaining variables before removing another variable. Selected interactions were investigated after the final reduced model had been identified; however, no significant interactions were observed. The slope and intercept were modeled as random effects. The final model contained 946 observations from the 327 patients.

### Results

#### Sample Characteristics

Approximately 16% of the patients ($n=51$) were identified as depressed at baseline, and almost 30% of the sample screened positively for depression at some time during the 1-year follow-up period. The characteristics of patients who were and were not depressed at baseline are displayed in Table 1. Compared with the nondepressed stroke patients, the depressed patients were younger ($P<0.02$), more likely to be

### Table 1. Sample Characteristics at Baseline

<table>
<thead>
<tr>
<th>Variable</th>
<th>Depressed (N=51)</th>
<th>Not Depressed (N=276)</th>
<th>Total Sample (N=327)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>63.6±8.90</td>
<td>66.9±9.63</td>
<td>0.0231</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td>0.588</td>
</tr>
<tr>
<td>$\leq$11 y</td>
<td>35.3 (18)</td>
<td>41.7 (113)</td>
<td>40.3 (131)</td>
</tr>
<tr>
<td>12 y</td>
<td>33.3 (17)</td>
<td>26.9 (73)</td>
<td>28.3 (92)</td>
</tr>
<tr>
<td>$\geq$12 y</td>
<td>31.4 (16)</td>
<td>31.4 (85)</td>
<td>31.4 (102)</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td>0.039</td>
</tr>
<tr>
<td>White</td>
<td>86.3 (44)</td>
<td>68.9 (188)</td>
<td>71.9 (235)</td>
</tr>
<tr>
<td>Nonwhite</td>
<td>13.7 (7)</td>
<td>31.1 (85)</td>
<td>28.1 (92)</td>
</tr>
<tr>
<td>Living situation</td>
<td></td>
<td></td>
<td>0.797</td>
</tr>
<tr>
<td>Living with someone</td>
<td>70.0 (35)</td>
<td>74.2 (201)</td>
<td>73.1 (237)</td>
</tr>
<tr>
<td>Living alone</td>
<td>24.0 (12)</td>
<td>21.4 (58)</td>
<td>21.6 (70)</td>
</tr>
<tr>
<td>Institutionalized</td>
<td>6.0 (3)</td>
<td>4.4 (12)</td>
<td>5.2 (17)</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td>0.912</td>
</tr>
<tr>
<td>Married</td>
<td>52.7 (27)</td>
<td>57.9 (157)</td>
<td>56.9 (185)</td>
</tr>
<tr>
<td>Not married</td>
<td>47.1 (24)</td>
<td>42.1 (114)</td>
<td>43.0 (140)</td>
</tr>
<tr>
<td>Barthel Index</td>
<td>85.5±15.6</td>
<td>89.3±15.7</td>
<td>0.1173</td>
</tr>
<tr>
<td>Stroke severity</td>
<td>9.27±1.78</td>
<td>9.27±1.72</td>
<td>0.9871</td>
</tr>
<tr>
<td>Health status utility measure</td>
<td>6.14±3.42</td>
<td>7.88±2.51</td>
<td>0.0010</td>
</tr>
</tbody>
</table>
TABLE 2. Mixed Model Results for Final Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>5.863</td>
<td>0.443</td>
<td>0.0001</td>
</tr>
<tr>
<td>Linear time</td>
<td>0.066</td>
<td>0.024</td>
<td>0.006</td>
</tr>
<tr>
<td>Quadratic time</td>
<td>-0.004</td>
<td>0.002</td>
<td>0.03</td>
</tr>
<tr>
<td>Living alone</td>
<td>0.687</td>
<td>0.309</td>
<td>0.03</td>
</tr>
<tr>
<td>Institutionalized</td>
<td>1.353</td>
<td>0.597</td>
<td>0.03</td>
</tr>
<tr>
<td>Barthel Index</td>
<td>0.016</td>
<td>0.004</td>
<td>0.0001</td>
</tr>
<tr>
<td>Depression</td>
<td>-1.685</td>
<td>0.337</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

There were 946 observations. The following were not significant in the models: seen by neurologist vs general practitioner, education, race, hemorrhagic vs ischemic stroke, and stroke severity.

Stability of Patient Health Status Utility Over Time

Patient health status utility measurements were stable over 12 months. The correlation between valuations at 1 and 6 months was 0.88 (P<0.0001), and the correlation between valuations at 1 and 12 months was 0.87 (P<0.0001).

Correlations Between Depression, Physical Function, and Patient Health Status Utility

Depression was inversely associated with health status utility at 1 month (r=-0.23, P<0.0006), 6 months (r=-0.26, P<0.0001), and 12 months (r=-0.27, P<0.0001) after stroke. Physical function was not significantly correlated with patient health status utility at either 1 month (r=0.10, P>0.27) or 12 months after stroke (r=0.07, P>0.31) but was correlated at the 6-month assessment, although the correlation was modest (r=0.15, P<0.025). Physical function was significantly correlated with depression at 6 months (r=-0.24, P<0.001) but not at either 1 month (r=-0.08, P<0.24) or 12 months (r=0.02, P>0.75) after stroke.

Adjusted Association Between Depression and Patient Health Status Utility

On the basis of the mixed-effects model, linear time, quadratic time, living alone, being institutionalized, physical function, and depression were significantly related to patient health status utility (Table 2). The significant linear (P<0.006) and quadratic (P<0.03) time effects indicated that patient health status utilities significantly increased 6 months after baseline and then decreased by 12 months after stroke. Patients who were depressed reported worse valuations of their health states over time than did other patients. Other factors that were related to lower health status utility over 12 months after stroke included living situation (living alone versus living with someone, P<0.03; being institutionalized versus living with someone, P<0.03) and worse physical function (P<0.001). Race, marital status, education, stroke severity, level of care, and type of stroke were unrelated to valuation of current health state among stroke patients over time.

Discussion

This is one of the first studies to examine psychological health and other determinants of patient health status utility scores among actual stroke patients and the stability of the scores over time. Virtually all previous studies on health status utility measurement have been based on hypothetical assessments and without regard for time of the assessment (relative to stroke onset) or psychological health state. Such studies imply that stroke-related physical impairments are the key determinants of a stroke patient’s valuation of his/her current health state.

We found that psychological health was an independent predictor of health status utility and at least as important as physical functioning. Even after adjusting for physical functioning and other factors that may influence how a stroke patient values his health state, patients who had significant depressive symptoms reported lower health status utility for their current health state, and this lower valuation persisted over time. Moreover, social environment, ie, living with someone, was another important determinant of health status utility. These results suggest that both physical and psychological health need to be considered in decision modeling of stroke practice patterns and outcomes. An additional reason for understanding health status utility is that it is related to patient compliance.

Decision modeling relies on health status utility scores in selecting preferred practices. Utility scores provide explicit information on the quality of life, which also incorporates the patients’ values. In soliciting utility assessments from patients for certain outcomes associated with practices, it is important to know the array of factors that will determine the assigned utility score. The present study shows that more than physical function must be incorporated into the process; utility scores must be adjusted for psychological health and social environment as well as for physical function.

This is the first study to show that stroke patients’ preferences for current health state are stable over time, at least during the first year after stroke occurrence. Although the time trend was statistically significant, the changes were small and unlikely to substantially affect conclusions drawn under decision-modeling exercises. This suggests that at least during the first year after stroke, the time point at which health status utilities are assessed may be less important than the patient’s psychological health status and social environment.

Our findings on the importance of depression in determining health status utility have particular relevance for post-stroke rehabilitation. Given innovations in the acute management of stroke and the accompanying decrease in the case fatality rate, an increasing number of stroke victims are...
surviving with residual disability. Little attention has been paid to the effects of depression on rehabilitative outcomes despite major depression being highly prevalent and persistent over time among stroke patients.

A better understanding of the poststroke effects of depression is particularly important in light of the increasing evidence indicating that depression is a significant predictor of mortality, rehospitalization, and increased disability. Morris et al found that patients who were rated as depressed 2 weeks after stroke were 3.4 times more likely to die over the subsequent 10 years. In addition, depression in poststroke patients has been shown to limit the degree of recovery from stroke at both 6 months and 2 years. Parikh et al concluded that early detection and treatment of depression might lessen the negative effects that depression can have on recovery.

Although we found that physical function and depressive symptoms are not highly correlated, previous studies of the association between depression and physical function in stroke patients have yielded inconsistent findings. Stern and Bachman found no relationship between depression and the ability to perform the activities of daily living. Others report a significant, but weak, correlation between these 2 variables. It seems likely that depressive symptoms are more related to some physiological change than solely to a response to loss of physical function. Although we did not examine any neurobiological factors, the importance of lesion location may be more important as a predictor of depression than loss of physical function.

Similar to the findings of Astrom et al, we found that poor social environment (eg, living alone or being institutionalized) was inversely related to patients’ valuations of their health states. Patients who lack social support, live alone, or have never been married are known to have an elevated risk of mortality and morbidity (ie, see Reference 55). Moreover, as individuals experience highly debilitating diseases such as strokes, there is a potential for a disruption of their social support system. Such disruptions in the social support system may take the form of actual reductions in the social support network or perceived loss of social support, and psychological and biological repercussions are likely (eg, depression). Stroke patients with minimal social support networks may be targeted as being at higher risk for subsequent problems.

Although little research has been conducted to assess the relationship between severity of stroke and patient preference, we found no relationship between baseline stroke severity and reported health status utility value. However, to the extent that stroke severity is reflected in more severe deficits, severity may be viewed as being related to health status utility through the level of physical impairment. The present and past studies report an association between health status utility and severity of physical deficits. Although previous studies used hypothetical situations among patients who have not experienced strokes or had only mild strokes (eg, see References 3 to 6), we queried patients who had actually experienced mild to more severe strokes and the associated physical and mental impacts. It appears that patients may be able to accurately assess their likely valuations of various physical health states hypothetically.

We recognize that our findings may be affected by a number of limitations inherent in a study of this type. First, our patient population was restricted to those patients who were able to personally respond to the interview, indicating they were less physically and psychologically compromised by their strokes. Although the differences between responders and nonresponders were not statistically significant, patients requiring proxy respondents had greater physical disabilities, as reflected by lower Barthel Index scores, and a greater proportion were institutionalized than among patients who could provide self-reports. Thus, our conclusions may be relevant only for mild to moderately severe stroke patients, or the relationships between the various determinants and health state preference may be conservative. We could not incorporate information on treatment for depression among patients who screened positively for depression because postdischarge treatment data were not collected. However, the primary care physician of each patient who screened positively for depression was notified of this fact. Therefore, we may have underestimated the prevalence and effects of depression in this sample because it is possible patients may have been receiving antidepressant therapy. Finally, although the VA is an equal access system, the patients are composed of male veterans; hence, the results of the present study need to be verified in a non-VA setting that includes women.

Despite these potential limitations to our findings, we conclude that psychological health and social environment are important determinants of patient health status utility in addition to physical functioning. In conducting stroke policy analyses, investigators need to include factors such as depression and living situation of the patients among the array of covariates if more accurate conclusions are to be drawn regarding preferred patterns of care. Timing of the measurement is a less important concern, because health status utility measurements among a recent stroke patient sample appear to be relatively stable over the 12-month poststroke period.

Appendix

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