Prediction of Hospital Disposition After Thrombolysis for Acute Ischemic Stroke Using the National Institutes of Health Stroke Scale

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**Background:** Early determination of discharge destination after acute stroke may promote earlier rehabilitation and reduce costs by shortening the duration of hospitalization.

**Objective:** To determine whether the National Institutes of Health Stroke Scale (NIHSS) score predicts disposition in stroke patients treated with thrombolysis.

**Design:** Cohort study.

**Setting:** Academic and community hospitals from 3 countries.

**Patients:** Five hundred forty-six patients with acute ischemic stroke treated with recombinant tissue plasminogen activator (rt-PA).

**Interventions:** Medical records were reviewed for demographic information, vascular risk factors, location of stroke, initial NIHSS score, acute hospital disposition, and complications of symptomatic or asymptomatic intracerebral hemorrhage (ICH).

**Main Outcome Measure:** Discharge destination to home, acute rehabilitation, or nursing facility.

**Results:** In multinomial regression analysis, increasing NIHSS score was a robust and independent predictor of discharge to rehabilitation or nursing facilities, roughly doubling for each 5-point increment. Patients who developed symptomatic ICH were never discharged to home, but asymptomatic ICH had no significant independent effect on disposition.

**Conclusions:** Stroke severity as determined by the admission NIHSS score is the major independent predictor of disposition after hospitalization and treatment with rt-PA for acute stroke in a broad-based population. However, symptomatic ICH after rt-PA is a catastrophic event that may preclude discharge to home.

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thrombolytic therapy on disposition. The present study draws on information about patients treated in community and academic hospitals and across several different countries. We hypothesized that in this diverse population the NIHSS score could predict immediate hospital disposition for patients treated with rt-PA and that the complication of ICH would increase the likelihood of discharge to rehabilitation or a nursing facility.

## METHODS

### SUBJECTS

Individual patient data were collected, in part prospectively and in part retrospectively, from 1205 patients with ischemic stroke. All were treated with intravenous rt-PA within 3 hours of stroke onset according to the National Institute of Neurological Disorders and Stroke (NINDS) rt-PA Stroke Trial protocol. Fifty-six stroke centers were invited to participate; 2 declined. The participating centers and groups included the Standard Treatment With Alteplase to Reverse Stroke study; the Stroke Treatment in the Community study; Cologne, Germany; 2 centers in Canada; and 49 centers in the United States. From this cohort, patients were excluded if data about disposition or initial NIHSS score were missing. Patients were also excluded if they died during hospitalization or left against medical advice, that the complication of ICH would increase the likelihood of discharge to rehabilitation or a nursing facility.

### STATISTICAL ANALYSIS

Univariate analyses were performed to test for associations between disposition site and each of the individual patient characteristics. Continuous variables were tested using analysis of variance, and categorical variables were evaluated using $\chi^2$ or Fisher exact test. All tests were 2-sided. Variables associated with disposition in univariate analysis at $P<.05$ were considered for multivariate analysis. Multinomial (polytomous) logistic regression analysis was performed to identify the variables associated with disposition to rehabilitation or nursing facilities, using discharge to home as the reference. The NIHSS was analyzed as an indicator categorical variable in 5-point intervals. In addition, for comparison with prior studies, we analyzed the NIHSS scores categorized as 5 or less, 6 to 13, and greater than 13. Regression analysis was performed to assess the importance of each potential variable as it affects the other assessments in the model. In the final model, associations were considered significant at $P<.05$. Primary results are expressed in terms of relative risk (RR). All analyses were performed using Stata version 7.0 (Stata Corp, College Station, Tex).

## RESULTS

### DESCRIPTION OF THE COHORT

The complete cohort comprised 1205 patients. Of these, 546 had complete data on baseline NIHSS score and disposition and therefore served as the primary cohort for this study. The population that was excluded because of missing information on disposition did not differ from the primary population by age or sex, but had more white participants (85.0% vs 72.0%, $P<.001$). The population that was excluded because of missing information on NIHSS score did not differ from the primary population by sex, but was slightly older (mean ± SD age, 69.2 ± 13.2 vs 66.2 ± 13.4 years; $P=.006$) and more often white (93.8% vs 75.4%, $P<.001$).

The mean ± SD age of the cohort used in the analysis was 65.6 ± 13.9 years (range, 24-92 years), and 56.3% were men. Most patients (72.0%) were white, 22.0% were black, and 6.0% had another racial identity. The baseline NIHSS score was 5 or less in 9.9% of patients, 6 to 10 in 28.4%, 11 to 15 in 24.0%, 16 to 20 in 24.2%, and greater than 20 in 13.6%. Similar numbers were discharged to home (44.0%) or rehabilitation (41.8%), and far fewer went to a nursing facility (14.3%). Table 1 summarizes the discharge destination for each degree of stroke severity.

### DISCHARGE DISPOSITION

Multinomial regression analysis was performed, retaining age, sex, and race in the model. Age, sex, and race did not significantly affect the likelihood of discharge to rehabilitation. However, increasing age was an independent predictor of nursing home placement (RR, 1.09; 95% confidence interval [CI], 1.06-1.12 per year; $P<.001$). Men were about half as likely as women to be discharged to a nursing facility (RR, 0.57; 95% CI, 0.32-1.02; $P=.06$), although this was of marginal significance. Whites were less likely than nonwhites to be discharged to nursing homes (RR, 0.50; 95% CI, 0.26-0.94; $P=.03$).

Baseline NIHSS score was a robust independent predictor of discharge to rehabilitation or nursing home, roughly doubling for each 5-point increment, as shown in Table 2. In addition, for comparison with prior studies, we analyzed the NIHSS scores categorized as 5 or less, 6 to 13, and greater than 13. Compared with patients with NIHSS scores

### Table 1. Initial National Institutes of Health Stroke Scale (NIHSS) Score and Posthospitalization Disposition

<table>
<thead>
<tr>
<th>Initial NIHSS Score</th>
<th>Home</th>
<th>Rehabilitation</th>
<th>Nursing Facility</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤5</td>
<td>39 (72.2)</td>
<td>13 (24.1)</td>
<td>2 (3.7)</td>
<td>54</td>
</tr>
<tr>
<td>6-10</td>
<td>89 (57.4)</td>
<td>55 (35.5)</td>
<td>11 (7.1)</td>
<td>155</td>
</tr>
<tr>
<td>11-15</td>
<td>61 (46.6)</td>
<td>55 (42.0)</td>
<td>15 (11.5)</td>
<td>131</td>
</tr>
<tr>
<td>16-20</td>
<td>37 (28.0)</td>
<td>65 (49.2)</td>
<td>30 (22.7)</td>
<td>132</td>
</tr>
<tr>
<td>&gt;20</td>
<td>14 (13.9)</td>
<td>40 (54.1)</td>
<td>20 (27.0)</td>
<td>74</td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
<td>228</td>
<td>78</td>
<td>546</td>
</tr>
</tbody>
</table>

*Data are expressed as number (percentage) of patients discharged to each destination based on initial NIHSS score.
of 6 to 15 were significantly more likely to go to rehabilitation (RR, 2.13; 95% CI, 1.06-4.31; P = .03) but not nursing homes (RR, 3.39; 95% CI, 0.74-15.57; P = .12). Patients with NIHSS scores greater than 15 were significantly more likely to go to rehabilitation (RR, 6.15; 95% CI, 2.94-12.83; P < .001) and particularly likely to require a nursing home (RR, 19.36; 95% CI, 4.23-88.61; P < .001). All other baseline variables were not independently associated with disposition.

**EFFECT OF ICH ON DISPOSITION**

For the 22 patients who survived a symptomatic ICH, none were discharged to home. In contrast, asymptomatic ICH was not associated with discharge destination in multinomial regression analysis adjusted for age, sex, race, and baseline NIHSS score.

**STROKE SEVERITY AT BASELINE AND SITE OF DISPOSITION**

This study demonstrates that stroke severity, as measured by the NIHSS, is the predominant predictor of discharge destination after initial hospitalization for patients with acute ischemic stroke treated with intravenous rt-PA. As expected, increasing severity is associated with greater likelihood of discharge to rehabilitation or nursing facilities. This result is logical and consistent with reports from 2 prior studies: the community-based Northern Manhattan Stroke Study cohort (which comprised a mostly Hispanic population in a specific geographic area) and a single hospital-based cohort study. These 2 prior studies and the present investigation concur that severe stroke symptoms (NIHSS score, >13 to 15) at the time of hospital admission is strongly predictive of nursing facility disposition. The disposition of patients who have had moderate strokes (NIHSS score, 6-15) is less well-defined in these studies, possibly reflecting a graded effect within this range or uncertainty with regard to prognosis in this category. We found that NIHSS scores of 6 to 10 were associated with discharge to home, while NIHSS scores of 11 to 15 were significantly associated with discharge to rehabilitation or nursing home placement. Posthospitalization disposition for moderate strokes may depend on several factors, including responsiveness to rt-PA, socioeconomic status, and support at home after acute hospitalization.

The distribution of stroke severity differed among the prior and present studies. In both prior studies, more than half of the patients had mild strokes (NIHSS score, ≤ 5). The present study’s small proportion (9.9%) of these milder strokes probably reflects a treatment-related bias. Because of the risk of complications inherent in the use of rt-PA, clinicians likely reserve this therapy for patients with more potentially disabling strokes. Therefore, the specific inclusion of patients treated with intravenous rt-PA in the present study increases the relative proportion of those having moderate or severe strokes and the number who ultimately require rehabilitation or nursing facility placement after acute hospitalization.

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Rehabilitation</th>
<th>Nursing Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age per year</td>
<td>1.01 (0.99-1.02)</td>
<td>1.09 (1.06-1.12)</td>
</tr>
<tr>
<td>Male sex</td>
<td>0.76 (0.51-1.13)</td>
<td>0.57 (0.32-1.02)</td>
</tr>
<tr>
<td>White race</td>
<td>0.78 (0.50-1.20)</td>
<td>0.50 (0.26-0.94)</td>
</tr>
<tr>
<td>Initial National Institutes of Health Stroke Scale score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 5</td>
<td>Referent</td>
<td>Referent</td>
</tr>
<tr>
<td>6-10 vs ≤ 5</td>
<td>1.78 (0.85-3.72)</td>
<td>2.31 (0.47-11.40)</td>
</tr>
<tr>
<td>11-15 vs ≤ 5</td>
<td>2.66 (1.25-5.65)</td>
<td>5.05 (1.04-24.40)</td>
</tr>
<tr>
<td>16-20 vs ≤ 5</td>
<td>5.31 (2.46-11.50)</td>
<td>16.30 (3.45-77.10)</td>
</tr>
<tr>
<td>&gt;20 vs ≤ 5</td>
<td>8.36 (3.41-20.50)</td>
<td>27.40 (5.35-140.00)</td>
</tr>
</tbody>
</table>

*Data are expressed as adjusted relative risk (RR) (95% confidence interval). Adjusted RRs reflect the probability of discharge to rehabilitation or nursing facility relative to the probability of discharge to home; RRs in bold were statistically significant.

**EFFECT OF THROMBOLYTIC THERAPY ON DISPOSITION**

The relationship between baseline NIHSS score and disposition to rehabilitation or nursing facility was less robust than in prior studies, particularly among patients with moderate strokes (NIHSS score, 6-15). In the present study, the likelihood of discharge to home was higher, and the variability of the dispositions relative to baseline NIHSS score was greater. Both effects are most likely related to the administration of intravenous rt-PA to all patients, and this is the first report, to our knowledge, on the use of the NIHSS score as a predictor of hospital disposition in a population composed of such patients. Many patients may have improved from their initial NIHSS score because of this treatment and were more likely to go home or less likely to go to a nursing facility, as previously reported in an economic analysis of the pivotal NINDS rt-PA Stroke Study. Even among patients with the most severe strokes (NIHSS score, >20), 18.9% were able to go home directly from the hospital. The greater variability may also reflect the complication of symptomatic ICH after rt-PA in some patients, which greatly reduced the chances of discharge to home.

**EFFECT OF ICH ON DISPOSITION**

Intracerebral hemorrhage is a known complication of treatment with rt-PA and was expected to have an effect on disposition. Our findings were consistent with clinical expectations. Symptomatic ICH was a catastrophic event, resulting in discharge to rehabilitation or a nursing facility, never directly to home. In contrast, asymptomatic ICH did not significantly affect disposition, after adjustment for other baseline factors. Because asymptomatic ICH is by definition clinically silent, it seems logical that this event had no discernible effect on disposition after acute care.

**ASSOCIATION OF AGE, SEX, AND RACE WITH NURSING HOME DISPOSITION**

In addition to stroke severity, we found that increasing age was a predictor of nursing home use, but not reha-
bilitation placement. The Northern Manhattan Stroke Study\textsuperscript{4} reported a similar relationship, with age older than 65 years increasing the probability of discharge to a nursing facility 2.5-fold. The effect of age is not surprising, and it is likely that psychosocial and clinical factors, not apparent in our data, are responsible for the increased requirement for nursing facilities with increasing age. Furthermore, older patients may be less able to care for themselves and may more commonly require long-term placement. This is supported by the fact that 90\% of nursing facility residents are older than 65 years.\textsuperscript{10} Sex was a marginally significant independent predictor of nursing home use. Women comprise 72\% of the nursing facility population in the United States and in other nations.\textsuperscript{10,11} Finally, nonwhite patients appeared more likely than whites to go to nursing homes. The cause of this possible racial disparity is unknown and may relate to differential socioeconomic status, but because race did not significantly affect discharge to rehabilitation, this finding may be more indicative of insufficient resources for care and recovery efforts at home in this population. Overall, these issues related to sex and race must be considered with great caution, as the population studied was drawn from multiple health systems, countries, and cultures, which could have contributed to these findings.

**POTENTIAL LIMITATIONS**

Our study is limited by the exclusion of 659 of the potential cohort of 1205 patients. The excluded population was mostly white, probably because data on disposition and NIHSS score were missing mainly from sites in Europe and Canada. Excluded patients also tended to be slightly older than the study population. The effect of these excluded patients is unclear, but may limit the generalizability of our findings. However, the present study population is diverse, drawing on patients from several different geographic locations in the Western hemisphere, and may be more generalizable than the 2 prior studies.\textsuperscript{4,5} Our study also lacks a detailed assessment of other factors that may affect posthospitalization discharge destination, such as socioeconomic status, prior living situation, and availability of support at home, but it is unlikely that these factors would have been associated with baseline stroke severity and therefore are unlikely to have been major confounders of our primary analysis. In contrast, cognitive and visual impairments could have been associated with severity and disposition, but these details were not systematically collected in this study.

**CONCLUSIONS**

This study found that increasing stroke severity, particularly with NIHSS scores greater than 10, increased the likelihood of discharge to rehabilitation or nursing homes instead of to home. This multinational community and academic center–based study reinforces the usefulness of the NIHSS score as a predictor of disposition after stroke. The NIHSS score can predict discharge disposition when thrombolysis is used, although possibly with less precision than in patients not given this treatment. Furthermore, symptomatic ICH is a devastating complication that significantly minimizes the possibility of discharge to home, while asymptomatic ICH has no effect on disposition.

Future studies should search for other variables, rapidly available at admission like the NIHSS score, that could improve prediction of disposition after acute care. In addition, simulations or decision analyses could be performed to assess whether cost savings may be realized by using the NIHSS score to initiate early planning for disposition immediately on admission.

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**Author contributions:** Study concept and design (Drs Schlegel, Tanne, and Kasner); acquisition of data (Drs Tanne, Demchuk, Levine, and Kasner); analysis and interpretation of data (Drs Tanne, Levine, and Kasner); drafting of the manuscript (Drs Schlegel, Tanne, and Kasner); critical revision of the manuscript for important intellectual content (Drs Schlegel, Tanne, Demchuk, Levine, and Kasner); statistical expertise (Dr Kasner); obtained funding (Drs Schlegel, Demchuk, Levine, and Kasner); administrative, technical, and material support (Drs Schlegel, Tanne, Levine, and Kasner); study supervision (Drs Levine and Kasner).

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**REFERENCES**