Evaluating and Predicting Outcome of Acute Cerebral Vascular Accident

HENRY G. DOVE, PH.D.,* KAREN C. SCHNEIDER, M.P.H.,* AND JAN D. WALLACE, M.D.†

SUMMARY: An innovative evaluation method is used to study the outcomes and clinical predictions for 97 patients with acute cerebral vascular accidents. The technique involved the participation of several professional disciplines in selecting baseline and treatment variables and making independent predictions about the functional status of patients upon discharge from the stroke treatment center. The data suggest that (1) baseline variables were more important than treatment variables in the participants' predictions about the patients' short-term outcomes; (2) stroke unit staff members were generally successful in predicting patients' functional status; and (3) stroke extensions and other complications are important factors which affect stroke patients' short-term outcomes.

THE EVALUATION of the quality of medical care for stroke patients has involved a variety of approaches. Some studies have compared stroke outcome in academic and community hospitals.¹ ² Others have concentrated on examining the value of intensive care units for acute stroke patients.³ ⁴ Cooper and associates discuss the development of a combined heart-stroke intensive care unit.⁵ Several investigators have evaluated inpatient rehabilitation units for patients with completed stroke.⁶ ⁷ ¹² A number of researchers have been interested in predicting the outcome of acute stroke.¹³ ¹⁶ Anderson and associates, using a modified version of Williamson's outcomes-oriented assessment method,¹⁷ compared estimated outcomes with actual measured outcomes for stroke patients who participated in a rehabilitation program.¹⁸ ¹⁹ This evaluation of the quality of medical care focuses on acute stroke patients cared for in a comprehensive stroke treatment center in a university-affiliated Veterans Administration medical center.

The objectives of this study were 1) to analyze the relationships among stroke patients' baseline characteristics on admission, treatment variables and outcome; and 2) to compare the stroke unit staff's outcome predictions for patients with the patients' actual outcomes.

The following research questions were addressed by the study:

1. What are the achieved functional status outcomes for a sample of stroke patients?
2. Do any treatment variables relate to outcome?
3. Which kind of variables — baseline or treatment — are most important in terms of the functional status outcome?
4. Which staff member's outcome predictions most closely match the stroke patients' actual outcomes?
5. Do the outcome predictions differ among the various medical disciplines represented by the stroke center staff?
6. Do the treatment variables affect the staff's outcome predictions?

Methods

Patients were identified for possible inclusion in the study from the daily report of admissions, discharges and transfers at the West Haven Veterans Administration Medical Center (WHVA/MC) for the period September 6, 1977 through January 22, 1981. This report enabled us to identify all one hundred seventy six (176) patients who were admitted into the Stroke Treatment Center during this period. Virtually all patients who enter the WHVA/MC emergency room with suspected stroke are admitted to the Stroke Treatment Center shortly after their arrival at the hospital. Most patients are admitted to the unit within 24 hours (mean: 6 hours) of the onset of symptoms. The average age of the patients was 62.7 years, with a range of 36 to 92 years.

Seventy-nine (79) patients were excluded for the following reasons: transient ischemic attack § (38), brain stem stroke (30), intracerebral hematoma with coma (4), previous stroke with severe disability (4), and subarachnoid hemorrhage (3). The study sample consisted of 97 acute cerebral vascular accident patients, classified using a system similar to that adopted by the ad hoc Committee on Cerebrovascular Disease of the National Institute of Neurological and Communicative Disorders and Stroke.²⁰

The Stroke Treatment Center at the WHVA/MC includes a four-bed, acute-care area as well as a subacute area for intensive rehabilitation. Patients remain in the acute care area until stabilized and are then moved to the subacute area. The average total length of stay in the Stroke Treatment Center was 29.5 days (range: 1–120 days).

Throughout the study, a single outcome variable was used: the functional status of the patient upon discharge from the subacute area of the center. The participants in the study believed that this measure,

$\text{§An additional 52 patients admitted to the Stroke Treatment Center during the study period for diseases other than stroke. Transient ischemic attack (TIA) is defined in this study as an episode of a neurological deficit which clears within 24 hours.²¹ ²²}$
although short-term in duration, was the single most meaningful outcome variable for patients and staff alike.

The study was conducted by the WHVA/MC Health Services Research staff and included the participation of two physicians, two nurses, a social worker and a neuropsychologist from the Stroke Treatment Center. After a review of the stroke literature and discussions with the Stroke Treatment Center Director, a preliminary list of variables thought to affect recovery from stroke were presented to the six stroke center participants.

The Health Services Research staff abstracted these variables from the medical records of five patients not in the sample, and asked the six participants to make predictions for each patient in this training sample in terms of the outcome variable. Predictions were made at two points: 1) upon admission into the acute area, using only admission or baseline variables; and 2) after a description of the patients' stay in the center, which included treatment variables such as the administration of aspirin on admission and complications. The participants were "blinded" as to other participants' predictions.

The list of variables were revised, based on the participants' reactions to the pilot study. The final variables adopted by the study participants are briefly described in table 1.

Severity of stroke was a baseline variable which was determined on admission to the Stroke Treatment Center and based on the first standardized neurological assessment. The scoring system, which has been used for more than ten years at the WHVA/MC, was determined heuristically to measure functional status, particularly relating to activities of daily living and ability to function in the outside world. The scores are comprised of measures of Mental Status, Aphasic, Motor Function, and Sensory Function. The scores of each dimension are determined as follows:

1. Mental Status:
   - 100 — fully awake
   - 75 — awake, time disorientation or mild confusion
   - 50 — lethargic, or disorientation and confusion
   - 25 — responds to pain only
   - 0 — coma
   - S — seizures

2. Aphasia:
   a. Comprehension:
      - 100 — understands language normally
      - 75 — points to named or written objects; not able to understand more complex written language
      - 50 — right-left orientation and three step commands
      - 25 — less than two step commands
      - 0 — no comprehension, no imitation
   b. Expression:
      - 100 — normal speech
      - 75 — speaks in phrases with hesitation
      - 50 — names objects, no phrases
      - 25 — says "yes/no" correctly and points to objects
      - 0 — no oral speech or ability to write

3. Motor Function Testing
   - 100 — normal strength
   - 75 — ability to hold limb elevated briefly
   - 50 — ability to raise limb against gravity
   - 25 — ability to move, but not raise limb
   - 0 — paralysis

4. Sensory Function Testing:
   a. Pin Stick
      - 100 — normal
      - 50 — altered
      - 0 — absent
   b. Position Sense:
      - 100 — normal
      - 75 — inaccurate appreciation of movement at slow rate
      - 50 — appreciation only with wide range or rapid movement
      - 25 — appreciation of movement at wrist but not fingers
      - 0 — absent
   c. Double Simultaneous Stimulation:
      (record as right = left, right over left, or left over right)
      - Touch Localization:
        - 100 — if right = left
        - 75 — correct body part, but not as accurate as contralateral "normal" side
        - 50 — recognized as appropriate limb only
        - 25 — recognize "correct" side only
        - 0 — no touch recognition

5. Visual field examination, presence or absence of:
   - Monocular deficit: Unable to count fingers in any quadrant, one eye.
   - Homonymous deficit: Unable to count fingers in one visual field or no response to visual threat in one visual field.

This assessment was performed by the nursing staff at admission and at regular intervals (every 2 hours while patient awake) to document changes in neurological status, with subjective interpolation of subtle change falling between the major grades. Important changes were confirmed by the attending physician. Appendix A provides additional information as to how the Neurological Assessment Score was used to place each patient into one of five severity categories:

Complication variables included stroke exacerbation/extension and "other complications." A stroke exacerbation or extension was defined in this study as a period of improvement or stabilization for at least 24 hours after the initial stroke, followed by a striking deterioration in neurological status — a 30 percent or greater drop in mental status, language or motor scores on the standardized neurological test. Our definition of
The variables listed in table 1 were abstracted from the medical records of the 97 patients in the sample. The six participants predicted functional status outcomes for these patients as they did in the pilot study. Each of the participants was given the appropriate data for each patient in the study in the same order. They recorded their functional status predictions for the patients using the six-point scale shown in table 1. Their predictions were made blindly, i.e., the participants were given no information about the others’ predictions or the patients’ identities. A reliability check on the participants was included as a part of the predicting activity.

Results

Baseline, Treatment and Outcome Relationships

The achieved functional status outcomes for the sample of stroke patients at discharge from the Stroke Treatment Center are shown in table 2. Approximately half of the patients had a highly successful outcome after stroke — ambulatory and independent in activities of daily living.

When the baseline variable, severity of stroke, was cross-tabulated with functional status outcome, the chi-squared statistic of 25.2 was highly significant (p < .0001). Table 3 shows crosstabulations using the Mantel-Haenszel method of the baseline, treatment and complication variables with functional status outcome controlling for the major baseline variable, severity of stroke after admission to the Stroke Treatment Center. It is important to emphasize that the outcome is determined at discharge from the Stroke Treatment Center and is thus a measure of recovery from the acute event. However, the long term prognosis is altered by most if not all of the complication variables. None of the baseline variables was significantly associated with outcome after adjusting for severity of stroke. The treatment variable — place on aspirin at admission to the center — was significantly associated with outcome. The data suggest that patients started on aspirin at admission were more likely to have a successful outcome (ambulatory and independent) than those who were not, after adjusting for severity of stroke. Unfortunately, there were not enough data for the other treatment variables listed in table 1 to include them in the analysis.

Stroke extensions and “other complications” were both significantly related to outcome. Table 3 shows that even after the severity of the stroke is taken into account, patients with stroke extensions or other complications were more likely to have a poor outcome. The prevention of a stroke extension or other complication is important in improving the short-term outcome of stroke patients.

Table 4 gives the results of a stepwise logistic regression procedure using baseline, treatment and complication variables as independent variables and outcome (successful/unsuccessful) as the dependent variable. The most important variables were initial
TABLE 2 Functional Status Outcomes for the Sample of 97 Stroke Unit Patients

<table>
<thead>
<tr>
<th>Outcome</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ambulatory and independent in activities of daily living (ADL)</td>
<td>49</td>
<td>50.5</td>
</tr>
<tr>
<td>2. Ambulatory and needs some help with ADL</td>
<td>14</td>
<td>14.4</td>
</tr>
<tr>
<td>3. Ambulatory with personal assistance and ADL with assistance</td>
<td>7</td>
<td>7.2</td>
</tr>
<tr>
<td>4. Not walking at all and ADL with assistance</td>
<td>12</td>
<td>12.4</td>
</tr>
<tr>
<td>5. Total care required</td>
<td>7</td>
<td>7.2</td>
</tr>
<tr>
<td>6. Deceased</td>
<td>8</td>
<td>8.2</td>
</tr>
<tr>
<td>Total</td>
<td>97</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Severity of stroke and stroke extension. The adjusted odds ratios shown in this table are of particular interest. For example, a patient with a class V stroke has a five-fold risk of having an unsuccessful outcome compared to a patient with a class II stroke. A patient having a stroke extension is 6.6 times more likely to have an unsuccessful outcome than someone without this complication.

TABLE 3 Summary of Cross-tabulations of Selected Baseline, Treatment and Complication Variables with Functional Status Outcome (Successful/Unsuccessful)* Controlling for Severity of Stroke at First Neurological Assessment after Admission to Stroke Treatment Center

| Variable | Overall | Mantel-Haenszel | $\chi^2$
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;60 (n = 43)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥60 (n = 54)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous stroke (no/yes)</td>
<td>2.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>no (n = 74)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes (n = 23)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart disease</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>absent (n = 58)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>present (n = 45)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>absent (n = 52)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>present (n = 45)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placed on aspirin</td>
<td>8.5+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes (n = 62)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no (n = 35)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroke extension</td>
<td>13.2+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>no (n = 64)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes (n = 33)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other complications</td>
<td>4.4$\dagger$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>none (n = 72)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes (n = 25)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Patients discharged from the subacute area of the center who were ambulatory and independent in activities of daily living were classified as having a successful outcome.
+ $p < 0.01$.
+ $p < 0.001$.
$\dagger$ $p < 0.05$.

TABLE 4 Stepwise Logistic Regression Using Initial Severity, Age, Previous Stroke, Hypertension, Heart Disease, Living Arrangement, Diabetes, Onset, Aspirin, Stroke Extension and Complications Against Functional Status at Discharge from Stroke Treatment Center (Successful/Unsuccessful Outcome*)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Adjusted odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial severity of stroke</td>
<td></td>
</tr>
<tr>
<td>class II</td>
<td>1.0†</td>
</tr>
<tr>
<td>class III</td>
<td>1.7</td>
</tr>
<tr>
<td>class IV</td>
<td>3.0</td>
</tr>
<tr>
<td>class V</td>
<td>5.2</td>
</tr>
<tr>
<td>Stroke extension</td>
<td>6.6</td>
</tr>
</tbody>
</table>

*Patients with successful outcomes were ambulatory and independent in ADL at discharge from the Stroke Treatment Center.
†Reference category.

Discussion

Baseline, Treatment and Outcome

This study showed that about half of the patients admitted with strokes (excluding TIA's, previous strokes with severe disabilities, brain stem strokes,
in intracerebral hemorrhages with coma and subarachnoid hemorrhages), had a successful outcome — ambulatory and independent at discharge. However, it is difficult to compare these findings with those of other studies for at least two reasons. First, criteria for accepting patients into a study sample vary considerably from study to study. For example, some researchers include patients with TIA’s in their study samples while others exclude this category (as did the present investigation). Second, stroke units vary from special intensive care units for a small number of critically ill patients admitted soon after the development of symptoms to units designed specifically for rehabilitation of patients with completed stroke.

The baseline variables were found to be more important than the treatment variables in predicting stroke outcomes as defined in this study. Stroke extensions which occurred and were theoretically preventable, however, were even more important factors relating to outcome. As expected, the most powerful, predictive baseline variable was the initial severity of the stroke. Although a comparison with other studies cannot be accurately made, other researchers have found severity of stroke to be a key factor in stroke outcome.

The treatment variable showing the strongest relationship with reduced stroke disability was treatment with aspirin on admission to the center. The reduced stroke disability was likely secondary to a decrease in incidences of stroke extensions; however, the small sample size precluded further statistical analyses for this relationship. Much work has been done in attempting to determine the effectiveness of aspirin in reducing the risk of completed strokes among patients with transient ischemic attacks. However, little has been reported about the use of aspirin in acute stroke. The results of this study should not be mistaken for those of a controlled experiment involving aspirin; however, our results, in our opinion, suggest that this avenue should be explored in future research.

The complication having the greatest effect on outcome was stroke extension. The data indicate that patients having exacerbations of the initial stroke are over six times more likely not to be ambulatory and independent on discharge from the center, regardless of the initial severity. Thirty-four percent of the patients (33) had stroke extensions. Preventing this complication of stroke would substantially improve the short-term and indeed years after discharge of patients, the functional status of the patient after a stroke. It is worth repeating that the definition of stroke extension used in this study was broader than that of Jones and Millikan who defined a “late exacerbation” as a significant worsening in neurological status after 48 hours of stable course. In this investigation, a stroke exacerbation was a major worsening following a relatively stable period of at least 24 hours.

**Predicted Versus Achieved Outcomes**

The six participants were generally very successful in predicting patient’s actual outcomes. No participant produced significantly better results than the others; no medical profession (nurse, physician, social worker and neuropsychologist) provided more accurate predictions than another. Participants improved their predictions when they had access to both admission data and data describing the patients’ stay in the center, particularly knowledge about stroke extensions and other complications.

The similarity of predictions made by the different participants and disciplines may reflect the fact that all members of the team meet daily to discuss each patient’s progress and, therefore, develop similar expectations for patients. Even though each participant made his/her predictions blindly, independently, individually and without any knowledge of the others’ predictions and indeed years after discharge of patients, the “team atmosphere” in the Stroke Treatment Center.

<table>
<thead>
<tr>
<th>Table 6 Comparing Participants’ Goal Setting Using Ridit Analysis for Ordered Data with the Distribution of Patients’ Actual Outcomes as a Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal</td>
</tr>
<tr>
<td>Goals using baseline only</td>
</tr>
<tr>
<td>physician 1</td>
</tr>
<tr>
<td>physician 2</td>
</tr>
<tr>
<td>nurse 1</td>
</tr>
<tr>
<td>nurse 2</td>
</tr>
<tr>
<td>neuropsychologist</td>
</tr>
<tr>
<td>social worker</td>
</tr>
<tr>
<td>Goals using all variables</td>
</tr>
<tr>
<td>physician 1</td>
</tr>
<tr>
<td>physician 2</td>
</tr>
<tr>
<td>nurse 1</td>
</tr>
<tr>
<td>nurse 2</td>
</tr>
<tr>
<td>neuropsychologist</td>
</tr>
<tr>
<td>social worker</td>
</tr>
</tbody>
</table>
probably helped the participants to make accurate — and similar — predictions.

Generalizability to Other Institutions
The method of evaluating patient care attracted the interest of the participants and offered insights into the care provided at the West Haven VA Medical Center. The method may be useful on other clinical problems. At other institutions, participants may choose different outcomes and/or process variables, depending on their perceived clinical relevance. It is likely — even desirable — that other outcome variables, for example, would be chosen.

Conclusion
The focus of this patient care evaluation was on acute stroke patients admitted to a stroke treatment center in a university-affiliated VA medical center. The study technique involved the participation of six stroke center staff members representing the professional disciplines of medicine, nursing, social work and neuropsychology. The participants helped to choose baseline, treatment and outcome variables thought to be important in recovery from stroke. They also predicted outcome for a sample of stroke patients.

The statistical analysis of the sample provided useful results:
1. Baseline variables — particularly initial severity of stroke — were more important than treatment variables in predicting short-term outcome from stroke.
2. The treatment variable that seems to warrant further experimentation is prescribing aspirin on admission.
3. Preventing late exacerbations would substantially improve stroke outcome.
4. Stroke Treatment Center staff members were generally successful in predicting patients’ functional status outcomes.
5. The method used to assess the care provided was both practical and flexible because it enabled the participants to suggest process and outcome variables that were clinically meaningful to them.

Appendix A
Severity of Stroke Based on Neurological Assessment Scoring*  
Used at the West Haven Medical Center

<table>
<thead>
<tr>
<th>Class</th>
<th>TIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Class I Mental Status 75—100. Other defects mild to moderate.</td>
</tr>
<tr>
<td>II</td>
<td>Class II Mental Status 50—75 OR minimal expressive or receptive aphasia (50—75) OR motor defects 25 or less.</td>
</tr>
<tr>
<td>III</td>
<td>Class III Mental Status 25—50 OR aphasia 25—50. Other defects need not be evident.</td>
</tr>
<tr>
<td>IV</td>
<td>Class IV Mental Status 0—25 OR aphasia 0—25. Other defects need not be evident.</td>
</tr>
</tbody>
</table>

*Scoring is done every 2 hours on patients (while awake) in the acute area of the Stroke Treatment Center. Scores range from 0–100 in areas including mental status, receptive aphasia, expressive aphasia, and motor-arm, motor-leg.

Guidelines for Deriving Severity of Stroke Classes for Stroke Audit Patients
1. Determine the five possible classes a patient would fall into based on individual scores in the following five areas: mental status, receptive aphasia, expressive aphasia, motor-arm, and motor-leg.
2. A patient’s class (I, II, III, IV, or V) was the lowest class that he clearly fell into.
3. If a patient’s lowest class fell between two classes in mental status or receptive or expressive aphasia, the other possible classes in the other two areas were used. If these were higher than the lowest of the “tied” classes, the patient was placed in the higher class. If all the mental status and aphasia classes were between the same two classes, then the lowest scores were considered. If these were high, the higher of the two classes was used to classify the severity of the stroke.

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A Randomized Trial of Team Care Following Stroke

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AND BERNICE MENDELSOHN, M.S.P.A.¶

DURING THE 1970s substantial attention was given to the value of stroke units in enhancing patient outcomes. As proposed by Bonner,1 a stroke unit may be either a multi-disciplinary team of stroke specialists who consult throughout a hospital and provide services wherever the patient is situated, or a defined geographic area of a hospital where stroke patients are admitted and care is provided by a stroke team.

Some attempts to evaluate the effects of stroke units on patients with acute lesions, have involved the comparison of care provided in specialized neurovascular intensive care units with regular ward care. Although three studies2-4 failed to show a significant decrease in outcomes.8-10 Patients cared for in these units were sometimes8 but not always,9,11 more frequently discharged to home. In-hospital mortality,7-11 and length of stay12 were not positively influenced, but the units appeared to be effective in promoting family participation in patient care and the rehabilitation process.8-10 A careful examination of this literature provides no consensus about the value of stroke units. Several studies suggest that the major effort exerted on behalf of the patient is helpful, but since only one of these studies was strictly randomized numerous questions remain.

The establishment of a stroke unit at the Sir Mortimer B. Davis Jewish General Hospital in Montreal,

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22. Jones HR, Millikan CH: Temporal Profile (Clinical Course) of Acute Carotid System Cerebral Infarction. Stroke 7: 64-71, 1976

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Summary

A randomized controlled trial was conducted to examine the effects of interdisciplinary team care on acute hospitalized stroke patients. After obtaining baseline information on 42 stroke victims receiving conventional care in a general hospital, 130 stroke patients were stratified and randomly assigned either to Traditional or Team care. Assessments by independent evaluators permitted comparisons between Team and Traditional groups with reference to patient survival, motor performance and functional abilities. Data obtained prospectively from charts and treatment logs allowed the care process across groups to be compared. Results demonstrated that Team and Traditional patients fared similarly in survival. However there was an unexpected difference in survival depending upon sex. For motor performance, male survivors performed better with Team care and female survivors with the Traditional method. In terms of functional abilities, male patients receiving Team care again performed better than their Traditional counterparts, whereas in women there was no difference between the treatment groups.

Stroke Vol 15, No 5, 1984
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*Stroke.* 1984;15:858-864
doi: 10.1161/01.STR.15.5.858

*Stroke* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1984 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

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