Utilization of Intravenous Tissue-Type Plasminogen Activator for Ischemic Stroke at Academic Medical Centers
The Influence of Ethnicity

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Background and Purpose—We sought to measure the overall rate of usage of tissue-type plasminogen activator (tPA) for ischemic stroke at academic medical centers, and to determine whether ethnicity was associated with usage.

Methods—Between June and December 1999, 42 academic medical centers in the United States each identified 30 consecutive ischemic stroke cases. Medical records were reviewed and information on demographics, medical history, and treatment were abstracted. Rates of tPA use were compared for African Americans and whites in univariate analysis and after adjustment for age, gender, stroke severity, and type of medical insurance with multivariable logistic regression.

Results—Complete information was available for 1195 ischemic stroke patients; 788 were whites and 285 were African Americans. Overall, 49 patients (4.1%) received tPA. In the subgroup of 189 patients without a documented contraindication to therapy, 39 (20.6%) received tPA. Ten (20%) of those receiving tPA had documented contraindication. African Americans were one fifth as likely to receive tPA as whites (1.1% African Americans versus 5.3%; \( P = 0.001 \)), and the difference persisted after adjustment (OR 0.21, 95% CI 0.06 to 0.68; \( P = 0.01 \)). When comparison was restricted to those without a documented contraindication to tPA, the difference remained significant (OR 0.24, 95% CI 0.06 to 0.93; \( P = 0.04 \)). Medical insurance type was independently associated with tPA treatment. After adjustment for ethnicity and other demographic characteristics, those with Medicaid or no insurance were one ninth as likely to receive tPA as those with private medical insurance (OR 0.11, 95% CI 0.02 to 0.17; \( P = 0.003 \)).

Conclusions—tPA is used infrequently for ischemic stroke at US academic medical centers, even among qualifying candidates. African Americans are significantly less likely to receive tPA for ischemic stroke. Contraindications to treatment do not appear to account for the difference. (Stroke. 2001;32:1061-1068.)

Key Words: cerebral infarction ▪ cerebrovascular disorders ▪ thrombolytic therapy

Inequities in health care due to ethnicity and socioeconomic status have been well documented.1–3 In the United States, black patients are less likely than white patients to receive a number of aggressive medical therapies, including coronary artery angioplasty and bypass surgery,4–7 thrombolysis for myocardial infarction,8 and tumor resection for lung8 and colon cancer.10 Though socioeconomic status also influences utilization of medical services, the effect of ethnicity persists after correction for income.6 These disparities in healthcare delivery are the focus of a major national effort as indicators of poor quality and social injustice.11

Stroke is the third leading cause of death, and incidence and mortality rates are greater for blacks than for other ethnic groups.12,13 Ischemic stroke accounts for two thirds of stroke cases. Well-established therapies for stroke prevention, such as carotid endarterectomy and anticoagulation for atrial fibrillation, are used less commonly among blacks.14 White patients are approximately 3 times as likely as black patients to receive endarterectomy, and the difference persists after adjustment for insurance status and income.14,15 The reason for the disparity is unclear; a higher incidence of carotid disease in whites may be partially responsible but cannot account for the entire disparity in endarterectomy rates.16

Tissue-type plasminogen activator (tPA) is an effective therapy for ischemic stroke when it can be initiated within 3 hours of symptom onset.17 It was approved by the Food and Drug Administration in 1996, and its use has been recommended in published consensus guidelines.18,19 However, it is
used in only a small portion of patients with ischemic strokes, even among those who meet eligibility criteria by arriving within 3 hours and having no contraindication to treatment.20,21 There are no data evaluating the influence of ethnicity and socioeconomic status on the use of tPA for ischemic stroke.

We evaluated predictors of tPA use in a cohort of ischemic stroke patients treated consecutively at academic medical centers throughout the United States. We chose academic medical centers because they were likely to have necessary facilities to support tPA administration, including physicians with stroke expertise and emergent interpretation of head CT scans.18,19 Because disparity in tPA use by ethnicity or socioeconomic status could result from differences in the timing of presentation or other contraindications to treatment, we also analyzed the subgroup of patients who had no apparent contraindication to tPA use according to national treatment guidelines.18,19 Finally, a larger database of discharge abstracts was used to evaluate institutional predictors of rates of tPA administration for ischemic stroke.

Subjects and Methods

Cohort Study

The University Health Systems Consortium (UHC) includes 84 academic medical centers throughout the United States. Members were invited to participate in a quality improvement project for ischemic stroke, and 42 agreed to participate (see the Appendix).

Medical records of 30 consecutive ischemic stroke patients admitted from June through December 1999 were reviewed at each participating center. Demographic information, medical history, treatment, and outcome were abstracted from documentation in the medical record. Ethnicity was abstracted from documentation by practitioners. Whites do not include those characterized as Latino. Insurance status was divided into private insurance, Medicaid/ uninsured, and Medicare or Civilian Health and Medical Program of the Uniformed Services (CHAMPUS). Severe strokes were defined as those with any of the following characteristics within 24 hours of admission: severe weakness (antigravity strength at best), global or near-global aphasia, obtundation or coma, or severe hemi-inattention or anosognosia. The timing of symptom onset, emergency department arrival, and tPA treatment, if given, were recorded. Any documentation of contraindications to tPA according to national treatment guidelines18,19 was recorded, including ongoing anticoagulation, failure to control acute hypertension, hemorrhage or extensive early infarction on head CT, and a minor or improving deficit. For a subgroup analysis, patients who arrived within 3 hours of symptom onset and did not have a documented contraindication to tPA were considered tPA candidates. Other reasons for failing to give tPA, such as decline by patient or family member, were also recorded.

Univariate analyses were performed with the Wilcoxon rank sum test for categorical variables. For dichotomous variables, P values were derived from the Pearson χ² test or from the Fisher exact test if any cell contained 5 or fewer observations; confidence intervals were derived from the method of Cornfield.22 Independent predictors of treatment with tPA were determined by using multivariable logistic regression with age, gender, ethnicity, insurance type, and source of admission (emergency department, transfer, or direct admission) were included in both data sets. In the discharge database, treatment with tPA was identified from the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) procedure code 99.10. Ethnicity is most often recorded during patient registration and is usually self-reported. Percent agreement and kappa statistics were calculated.

To confirm that associations were not caused by sampling errors and to evaluate institutional characteristics as predictors of tPA delivery, we retrieved all ischemic strokes admitted through the emergency department in the complete 1999 UHC discharge database. All patients with a primary diagnosis of ischemic stroke (ICD-9-CM 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, or 436) were included.23–25 Predictors of treatment with tPA were again determined using univariate analysis, as described above, and with multivariable logistic regression adjusting for age and gender. To determine whether ethnicity mix of hospitals was associated with rates of tPA delivery, the percentage of ischemic stroke patients who were African American and the percentage of African Americans with ischemic strokes who received tPA were calculated for each institution. Correlation coefficients were calculated for these institutional characteristics, weighting each institution by the number of patients treated there. Hospitals were divided into regions as follows: the West region included Montana, Wyoming, Colorado, and other states farther to the west; the Southeast region included and was bordered by Oklahoma, Arkansas, Kentucky, West Virginia, and Virginia; Midwest included and was bordered by Ohio to the east; and Northeast included the remaining region.

Results

Cohort Study

Complete information was provided on 1195 ischemic stroke patients consecutively treated at 42 academic medical centers. tPA was administered to 49 patients (4.1%). Ages were similar for those receiving tPA compared with others (mean±SD, 64±17 versus 66±15 years; P=0.50). Rates of tPA use were similar for men and women (Table 1). Black patients were one fifth as likely to receive tPA as white patients (1.1% blacks versus 5.3% whites; P=0.001), and the difference persisted after adjustment for age, gender, type of insurance, and stroke severity (OR 0.21, 95% CI 0.06 to 0.68; P=0.01). Numbers of Latinos, Asians, and Native Americans were small, and rates of tPA administration in these groups were not significantly different from those of whites.

There were differences in rates of tPA use according to type of medical insurance (Table 1). Four percent of patients with Medicare or CHAMPUS received tPA. Those with Medicaid or no insurance were less likely to receive tPA than those with private insurance (0.9% versus 6.7%; P<0.001), and the difference persisted after adjustment for age, gender, ethnicity, and stroke severity (OR 0.11, 95% CI 0.02 to 0.17; P=0.003).

tPA was used more commonly in those with severe strokes (Table 1). However, the percentage of severe strokes was similar for blacks and whites (18% versus 16%; P=0.35). The frequency of severe strokes was also similar in those with no insurance or Medicaid compared with others (15% versus 17%; P=0.97).

The time of symptom onset was known in 511 patients, and 219 (18%) arrived in the emergency department within 3 hours. Time of onset was not recorded if the patient awoke or was found with the deficit, so those without a recorded onset time would not have been tPA candidates. There was a trend toward a briefer delay between symptom onset and arrival in
A total of 189 ischemic stroke patients (16%) arrived within 3 hours of symptom onset and did not have another documented contraindication to tPA; these were defined as tPA candidates. Ten (20%) of those receiving tPA had a documented contraindication. Eighteen percent of whites (n = 138) were tPA candidates compared with 13% of blacks (n = 56; P = 0.06). Ten of 58 Latinos (17%) and 5 of 46 Asian Americans (11%) were tPA candidates. Insurance status was not associated with being a tPA candidate (P = 0.25).

When analysis was restricted to tPA candidates, tPA use was still less frequent in blacks (Table 2). Black tPA candidates were about one third as likely to receive tPA as those who were white (8.3% versus 24.6%; P = 0.04). The magnitude of the difference was similar after adjustment for age, gender, insurance status, and stroke severity (OR 0.24, 95% CI 0.06 to 0.93; P = 0.04). If the cohort was restricted to the 179 patients arriving within 2 hours rather than within 3 hours, blacks were still less likely to receive tPA compared with whites (8.3% versus 24.4%; P = 0.04), but the difference was not statistically significant after adjustment (OR 0.26, 95% CI 0.07 to 1.06; P = 0.06).

Among tPA candidates, 7% of those with Medicaid or no insurance, 21% of those with Medicare or CHAMPUS, and 27% of those with private insurance received tPA. tPA candidates with Medicaid or no insurance were significantly less likely to receive tPA than those with private insurance (P = 0.03), but the difference was not significant after adjustment for demographic characteristics and stroke severity (OR 0.33, 95% CI 0.06 to 1.85; P = 0.21).

### Discharge Database Study
In a confirmatory and exploratory analysis, we used the UHC database of discharge abstracts to determine whether the sample we had obtained was representative of the population of patients admitted to the larger membership of academic medical centers and to determine whether institutional characteristics were associated with tPA administration. In a validation study of the 927 patients listed in both the medical record review and in the discharge database, we found that there was high agreement in those identified as non-Latino whites (97% agreement, κ = 0.93) and blacks (100% agreement, κ = 0.99). Coding in the discharge database was highly specific for thrombolysis (specificity 100%), with all 17 cases

### Table 1. tPA Use in Patients With Ischemic Strokes Treated at Academic Medical Centers (n=1195)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>tPA Used, n (%)</th>
<th>Univariate OR (95% CI)</th>
<th>P</th>
<th>Adjusted OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
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<tr>
<td>Male, n=608</td>
<td>29 (4.8)</td>
<td>0.70 (0.40–1.25)</td>
<td>0.23</td>
<td>0.73 (0.40–1.33)</td>
<td>0.31</td>
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<tr>
<td>Female, n=587</td>
<td>20 (3.4)</td>
<td></td>
<td>0.001</td>
<td>0.21 (0.06–0.68)</td>
<td>0.14</td>
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<tr>
<td>Ethnicity</td>
<td></td>
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</tr>
<tr>
<td>White, n=788</td>
<td>42 (5.3)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Black, n=285</td>
<td>3 (1.1)</td>
<td>0.25 (0.14–0.44)</td>
<td>&lt;0.001</td>
<td>0.22 (0.12–0.42)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Latino, n=58</td>
<td>4 (6.9)</td>
<td>0.12 (0.0–0.46)</td>
<td>&lt;0.001</td>
<td>0.11 (0.02–0.17)</td>
<td>0.003</td>
</tr>
<tr>
<td>Native American, n=6</td>
<td>0 (0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Asian, n=46</td>
<td>0 (0)</td>
<td>0 (0–1.49)</td>
<td>0.16</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td>Other, n=12</td>
<td>0 (0)</td>
<td>0 (0–5.78)</td>
<td></td>
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<tr>
<td>Insurance type</td>
<td></td>
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<tr>
<td>Private, n=371</td>
<td>25 (6.7)</td>
<td>0.25 (0.14–0.44)</td>
<td>&lt;0.001</td>
<td>0.22 (0.12–0.42)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Medicaid/CHAMPUS, n=567</td>
<td>22 (3.9)</td>
<td>0.56 (0.31–1.00)</td>
<td>0.05</td>
<td>0.62 (0.31–1.22)</td>
<td>0.17</td>
</tr>
<tr>
<td>Medicaid/none, n=234</td>
<td>2 (0.9)</td>
<td>0.12 (0–0.46)</td>
<td>&lt;0.001</td>
<td>0.11 (0.02–0.17)</td>
<td>0.003</td>
</tr>
<tr>
<td>Stroke severity</td>
<td></td>
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<tr>
<td>Severe, n=199</td>
<td>21 (10.6)</td>
<td>0.31 (0.17–0.57)</td>
<td>0.001</td>
<td>0.29 (0.14–0.53)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Other, n=996</td>
<td>28 (2.8)</td>
<td>0.25 (0.14–0.44)</td>
<td>&lt;0.001</td>
<td>0.22 (0.12–0.42)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Ref indicates reference category.
For unadjusted comparisons, CIs were calculated using the method of Cornfield and P values were derived from the Pearson χ² test or Fisher exact test if any cell contained ≤5 observations. For adjusted comparisons, P values and CIs were determined using logistic regression with all listed variables in the model.

The percentage of the entire cohort arriving within 3 hours was similar (20% whites versus 16% blacks; P = 0.18). Of the 219 patients arriving within 3 hours, other contraindications to tPA were documented in 30 patients (14%), including ongoing anticoagulation (n = 6), persistent hypertension (systolic blood pressure >185 mm Hg or diastolic blood pressure >110 mm Hg) unresponsive to medications in the emergency department (n = 10), extensive CT changes consistent with early infarction (n = 4), and mild or rapidly improving symptoms (n = 10). There was a trend toward more frequent tPA contraindications among black patients arriving within 3 hours of symptom onset, but the difference was not significant (22% versus 12% for whites; P = 0.08). Three patients, all whites, were documented to have declined tPA.
with the ICD-9-CM code receiving thrombolysis by record review, but was insensitive (sensitivity 50%), with detection of 17 of the 34 cases given tPA. One hospital never used the ICD-9-CM code for tPA administration (99.10) even though treatment had been documented in 4 cases by medical record review. The code does not alter reimbursement in most instances, which may explain its insensitivity in administrative data. When hospitals that never coded tPA administration in the discharge database were eliminated, the sensitivity increased (57%). Subsequent analyses were restricted to hospitals that had ever used the code for tPA. There was no association between ethnicity and correct coding of tPA in the discharge database among patients receiving tPA by record review.

In 1999, 8608 patients with ischemic strokes were admitted through the emergency department to UHC hospitals that had ever coded administration of tPA for ischemic stroke. Of these, 205 (2.0%) received tPA; 148 were white and 38 were black. White patients were more likely to receive tPA than were black patients (2.9% versus 1.6%; \( P = 0.0001 \)). tPA was administered to 1.6% of Latinos (\( n = 8 \)) and 1.8% of Asians (\( n = 5 \)), but these rates were not significantly different from those of whites. After adjustment for age and gender, blacks were still less likely to receive tPA (compared with whites, OR 0.50, 95% CI 0.36 to 0.71; \( P < 0.001 \)); inaccurate coding in the discharge database may have reduced the apparent association. Age and gender were not associated with receiving tPA.

Of the 66 hospitals ever coding administration of tPA for ischemic stroke, the portion of emergency department patients with ischemic stroke treated with tPA ranged from 0 to 12.5%, with a median of 1.9%. The proportion of black patients treated with tPA ranged from 0% to 33%, with a median of 0%; >50% of hospitals failed to treat a single black patient. At the 43 institutions with at least 1 black patient, the ratio of black to white rates of tPA use varied from 0 to 3.3, with a mean 0.4 and median 0. Fifty-nine of 66 institutions (84%) had ratios <1, indicating that whites were more likely than blacks to receive tPA there. Hospitals that treated a larger percentage of blacks for ischemic strokes did not have lower rates of tPA use among black patients (Figure) (\( R^2 = 0.02; P = 0.89 \)). Further, there was no difference in the portion of patients who were black at those hospitals ever using tPA compared with those never using tPA (\( P = 0.82 \)).

![Association between an institution’s percentage of ischemic strokes in black patients and the rate of tPA use in black patients.](http://stroke.ahajournals.org/)

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**TABLE 2. tPA Candidates With Ischemic Strokes (n=189)**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>tPA Used, ( n (%) )</th>
<th>Univariate OR (95% CI)</th>
<th>( P )</th>
<th>Adjusted OR (95% CI)</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
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<tr>
<td>Male, ( n = 98 )</td>
<td>22 (22.4)</td>
<td>Ref</td>
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<td>Ref</td>
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<tr>
<td>Female, ( n = 91 )</td>
<td>17 (18.7)</td>
<td>0.79 (0.40–1.60)</td>
<td>0.52</td>
<td>0.85 (0.39–1.85)</td>
<td>0.69</td>
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<tr>
<td><strong>Ethnicity</strong></td>
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<tr>
<td>White, ( n = 138 )</td>
<td>34 (24.6)</td>
<td>Ref</td>
<td></td>
<td>Ref</td>
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</tr>
<tr>
<td>Black, ( n = 36 )</td>
<td>3 (8.3)</td>
<td>0.28 (0.09–0.91)</td>
<td>0.04</td>
<td>0.24 (0.06–0.93)</td>
<td>0.04</td>
</tr>
<tr>
<td>Latino, ( n = 10 )</td>
<td>2 (20.0)</td>
<td>0.81 (0–3.37)</td>
<td>1.00</td>
<td>0.97 (0.15–6.13)</td>
<td>0.98</td>
</tr>
<tr>
<td>Asian, ( n = 5 )</td>
<td>0 (0)</td>
<td>0 (0–2.44)</td>
<td>0.34</td>
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<tr>
<td><strong>Insurance type</strong></td>
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<tr>
<td>Private, ( n = 68 )</td>
<td>18 (26.5)</td>
<td>Ref</td>
<td></td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Medicare/CHAMPUS, ( n = 92 )</td>
<td>19 (20.7)</td>
<td>0.72 (0.35–1.50)</td>
<td>0.39</td>
<td>0.66 (0.27–1.62)</td>
<td>0.37</td>
</tr>
<tr>
<td>Medicaid/none, ( n = 29 )</td>
<td>2 (6.9)</td>
<td>0.21 (0–0.87)</td>
<td>0.03</td>
<td>0.33 (0.06–1.85)</td>
<td>0.21</td>
</tr>
<tr>
<td><strong>Stroke severity</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Severe, ( n = 39 )</td>
<td>17 (43.6)</td>
<td>Ref</td>
<td></td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td>Other, ( n = 150 )</td>
<td>12 (8.0)</td>
<td>0.11 (0.05–0.26)</td>
<td>&lt;0.001</td>
<td>0.20 (0.09–0.47)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Ref indicates reference category.

For unadjusted comparisons, CIs were calculated using the method of Cornfield and \( P \) values were derived from the Pearson \( \chi^2 \) test or Fisher exact test if any cell contained <5 observations. For adjusted comparisons, \( P \) values and CIs were determined using logistic regression with all listed variables in the model. No Native Americans were tPA candidates.
Ischemic stroke patients were more likely to be black at hospitals in the Southeast (Table 3). Rates of tPA administration were greatest in the Midwest. Whites were more likely to receive tPA than blacks in all regions except for the Southeast, where rates of administration were similar.

**Comment**

We found that blacks admitted for ischemic strokes to academic medical centers were one fifth as likely as whites to receive tPA after adjustment for insurance status and stroke severity. Though black patients tended to have more frequent contraindications to tPA administration and a longer delay in presentation, these differences were not significant. Further, among those patients who were apparent candidates for tPA, blacks were still only one fourth as likely as whites to receive the drug. An analysis using a large administrative database of academic medical centers throughout the United States confirmed the ethnic disparity in tPA use for ischemic stroke.

The magnitude of the disparity is particularly large. Other studies have tended to find smaller ethnic differences in utilization of medical procedures. Disparities have tended to be larger for more aggressive and newer procedures and those that involve greater discretion of the practitioner or the patient, such as spinal laminectomy and tonsillectomy. tPA administration is an aggressive procedure, and the difficulty in weighing risks and benefits has supported some practitioners’ decisions to decline offering treatment.

There are several possible explanations for the disparity in ethnicity for tPA use in ischemic stroke patients. Failure of blacks to seek medical therapy rapidly does not appear to be the major cause of the ethnic disparity. Prior studies have demonstrated more delayed presentation for myocardial infarction in blacks. In our study, there was a nonsignificant trend toward longer delays in presentation, but a similar percentage of blacks and whites arrived within 3 hours of symptom onset. Further, a large difference in tPA usage between whites and blacks persisted even in those who arrived within 3 hours of symptom onset and had no other contraindication to tPA. Regardless, given the large portion of patients arriving beyond 3 hours, targeting the black population for educational campaigns to encourage early evaluation for ischemic stroke symptoms could reduce the difference. However, its effect may be less dramatic than targeting medical decision making, since delayed presentation did not appear to account for the overall disparity between ethnicities.

A greater distrust in the medical system and lack of confidence in treatment may contribute to the ethnic disparity in tPA delivery. A prior study found that black patients are more likely to feel excluded from medical decision making, potentially contributing to miscommunication and a sense of distrust. Blacks with a recent stroke or transient ischemic attack expressed more aversion to risk when questioned about potential endarterectomy. However, in our study no black patients were documented to have declined tPA treatment, whereas 3 white patients did.

Ethnic differences in stroke etiology or severity could account for some disparities in stroke treatments. For example, blacks are less likely than whites to have extracranial carotid artery stenosis, and this may account for some of the difference in rates of carotid endarterectomy. tPA appears to be effective for all ischemic stroke subtypes and is recommended regardless of subtype, age, gender, or ethnicity, except in those with isolated, mild neurological deficits or those with rapid improvement.

There were no apparent differences in stroke severity between the ethnicities, and rapid improvement was listed as a contraindication to usage in only a small portion of both whites and blacks. Therefore, ischemic stroke etiology and severity do not appear to account for ethnic differences in tPA usage.

Biases based on ethnicity and socioeconomic status are another possible explanation for disparities in tPA administration for ischemic stroke. If present, these biases may not be overt or conscious. It has been argued that acknowledging the force of racism is necessary to correct disparities in health care. In our study, ethnic differences persisted even when analysis was restricted to those who were appropriate candidates for tPA, and patient refusal did not explain the difference. Though a more detailed analysis of factors predicting treatment is required, it seems likely that racism contributed to the disparity in tPA treatment for ischemic stroke.

Our study was based on a sample of academic medical centers, and generalization outside this setting may be inappropriate. However, carotid endarterectomy, upper gastrointestinal endoscopy, and coronary angiography were more likely to be performed for medically appropriate reasons at teaching hospitals, thus reducing the likelihood that ethnicity influenced decision making. Therefore, nonacademic centers may have even larger ethnic disparities than those seen in our study. Another limitation is the retrospective nature of data collection in our study. Though some variables may have been inaccurately specified during abstraction from docu-

### Table 3. US Region and tPA Use at Academic Medical Centers

<table>
<thead>
<tr>
<th>Region*</th>
<th>Blacks, n (%)</th>
<th>Rate of tPA Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall</td>
<td>Whites</td>
</tr>
<tr>
<td>Northeast, n=2629</td>
<td>702 (27)</td>
<td>1.7%</td>
</tr>
<tr>
<td>Southeast, n=2481</td>
<td>980 (40)</td>
<td>2.1%</td>
</tr>
<tr>
<td>Midwest, n=1645</td>
<td>426 (26)</td>
<td>4.1%</td>
</tr>
<tr>
<td>West, n=1853</td>
<td>293 (16)</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

*Regions are defined in the text.
†White vs black by Pearson χ² test.
sentation in medical records, it is unlikely that this misclassification is severe with respect to tPA administration and ethnicity, both of which should be reliably obtainable in the medical record. Also, a systematic bias in recording ethnicity and tPA use seems unlikely, and nonsystematic misclassification would be expected to reduce the apparent associations.

Reductions in ethnic disparities in delivery of specific interventions have been documented. For example, the ratio of black to white rates of cardiac catheterization increased from 0.42 in 1980 to 0.91 in 1993. In our study, small ethnic differences in some regions and at some institutions also demonstrate the potential for improvement. In our study, the absence of ethnic disparity in the Southeastern United States suggests that differential barriers to treatment are not absolute. Factors responsible for more equitable use in the Southeast are unknown. More equitable delivery at hospitals with a larger percentage of black patients does not appear to account for the difference, since these hospitals did not use tPA more frequently in blacks. Several institutions treated a larger percentage of blacks than whites with tPA, which also confirms the potential to reduce disparities. Further, some institutions and some regions had much higher rates of tPA usage overall, demonstrating the potential to improve tPA delivery to all patients.

Intravenous tPA is the first proven therapy for acute ischemic stroke, and its introduction has dramatically changed the atmosphere surrounding stroke therapy. The slow and incomplete incorporation of tPA into general practice has been disappointing, as demonstrated in this study by the low rate of usage (21%) even among qualifying candidates presenting to academic medical centers and a very low rate of usage (4.1%) overall. Even more dramatic underutilization in blacks requires further research to identify and correct the sources of the disparity. Though we cannot definitively implicate racism as the primary etiology, practitioners should carefully examine their own motivations when withholding this proven therapy.

Appendix

Hospitals contributing to the cohort study are listed below, ordered by region and state.

West Region: University Medical Center Corporation, Ariz; Stanford Health Services, Calif; UC Irvine Medical Center, Calif; UCLA Healthcare, Calif; UC San Diego Healthcare, Calif; UCSF Medical Center, Calif; Denver Health, Colo; University of Colorado Hospital, Colo; University Medical Center of Southern Nevada, Nev; Oregon Health Sciences University, Ore; University of Utah, Utah; Harborview Medical Center, Wash.

Midwest Region: University of Illinois at Chicago Medical Center, Ill; Clarian Health Partners, Ind; University of Iowa Hospitals and Clinics, Iowa; Medical College of Ohio, Ohio; Ohio State University Medical Center, Ohio; University Cincinnati Hospital, Ohio; University Hospitals of Cleveland, Case Western Reserve University, Ohio; Froedtert Memorial Lutheran Hospital, Wis; University of Wisconsin, Wis; Wausau Hospital, Wis.

Southeast Region: UAB Health System, Ala; University Hospital of Arkansas, Ark; Howard University Hospital, Washington, DC; University of Kentucky Hospital, Ky; University Health Systems of Eastern Carolina, NC; Wake Forest University Baptist Medical Center, NC; University of Texas Medical Branch, Galveston, Tex; Medical College of Virginia Hospitals, Va; University of Virginia Health System, Va.

Northeast Region: Yale-New Haven Hospital, CT; Beth Israel Hospital, Mass; University of Massachusetts Memorial Health Care, Mass; University of Maryland Medical System, Md; University of Medicine and Dentistry of New Jersey, NJ; Albany Medical Center, NY; NYU Medical Center of Mount Sinai, NY; University Hospital and Medical Center at Stony Brook, NY; University Hospital of SUNY Upstate Medical University, NY; Thomas Jefferson University Hospital, Pa; University of Pennsylvania, Pa.

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28. Gittelsohn AM, Halpern J, Sanchez RL. Income, race, and surgery in rural medical facilities. With the ongoing effort to educate the community to recognize signs and symptoms of stroke, reports have shown that significant numbers of stroke patients can reach an emergency room (ER) within 3 hours. The current study by Johnston et al showed that 18% reached the ER within 3 hours. The Minnesota Stroke Survey reported that 50% of 1334 patients arrived at the ER within 3 hours.1 Most recently, the S.T.R.O.K.E. Collaborative Study Group reported that 46% of 553 patients arrived at ER within 3 hours.2 Treating acute stroke patients with IV tPA not only saves lives but also saves cost to the healthcare system. By applying the Markov model to estimate the costs per 1000 eligible stroke patients treated with IV tPA in the NINDS rt-PA Stroke Trial, Fagan et al3 reported that while there is a $1.7 million increase in the acute hospitalization costs, there is a decrease of approximately $6.2 million in rehabilitation and nursing home costs. While we are anxiously searching for more options in the management of acute strokes (yet there has been no recent significant breakthrough), many lives and brains can be saved by developing a stroke program that IV tPA can be delivered to appropriate acute ischemic stroke patients within 3 hours. With structured educational programs, healthcare professionals are likely to modify their behavior. As reported by Villar-Cordova et al4, the majority of neurologists were using or planning to use IV tPA soon after FDA approval. Therefore, as the medical providers, we have no reason not to establish a stroke program to manage stroke patients appropriately and urgently.

Healthcare professionals should pay serious attention to the results reported by Johnston et al. By examining consecutive ischemic stroke patients at 42 academic medical centers in the University Health System Consortium, they found that intravenous (IV) tPA is infrequently used in acute ischemic stroke patients presenting within 3 hours of onset, and African American stroke patients are even less likely to receive IV tPA. This time we have learned that the 2 problems identified lie within the medical providers.

It is conceivable that during the early stage of FDA approval of tPA, many physicians were skeptical about the therapy. Since then, nearly 5 years have passed, and multiple subsequent studies have provided evidence that good outcomes can be achieved in acute stroke patients treated with tPA either at academic, community, or rural medical facilities. With the ongoing effort to educate the community to recognize signs and symptoms of stroke, reports have shown that significant numbers of stroke patients can reach an emergency room (ER) within 3 hours. The current study by Johnston et al showed that 18% reached the ER within 3 hours. The Minnesota Stroke Survey reported that 50% of 1334 patients arrived at the ER within 3 hours.1 Most recently, the S.T.R.O.K.E. Collaborative Study Group reported that 46% of 553 patients arrived at ER within 3 hours.2 Treating acute stroke patients with IV tPA not only saves lives but also saves cost to the healthcare system. By applying the Markov model to estimate the costs per 1000 eligible stroke patients treated with IV tPA in the NINDS rt-PA Stroke Trial, Fagan et al3 reported that while there is a $1.7 million increase in the acute hospitalization costs, there is a decrease of approximately $6.2 million in rehabilitation and nursing home costs. While we are anxiously searching for more options in the management of acute strokes (yet there has been no recent significant breakthrough), many lives and brains can be saved by developing a stroke program so that IV tPA can be delivered to appropriate acute ischemic stroke patients within 3 hours. With structured educational programs, healthcare professionals are likely to modify their behavior. As reported by Villar-Cordova et al4, the majority of neurologists were using or planning to use IV tPA soon after FDA approval. Therefore, as the medical providers, we have no reason not to establish a stroke program to manage stroke patients appropriately and urgently.

Editorial Comment

It Is Time to Implement Stroke Practice Improvement Programs and Prevent the Racial Disparity in Stroke Care
It is alarming to learn that racial disparity can have an impact on the opportunity to receive IV tPA. The current study by Johnston et al showed that black patients are one fifth as likely to receive IV tPA as white patients, and >50% of the 42 participating academic hospitals failed to treat a single black patient. As we have learned, among the 3 most common causes of death in adults, the mortality ratio of the blacks to whites is greatest for stroke: 1.97 for men and 1.76 for women. Therefore, having access to and appropriately treating black stroke patients will have a significant impact on their survival and well being. Johnston et al have postulated the potential explanations for such a large racial disparity. Distrust, lack of confidence in treatment, ethnicity, and socioeconomic status bias, although these may be subconscious, are some of the factors. While further research may help us understand more specifically the racial disparity in stroke care, an education effort should take place immediately to identify and offer IV tPA treatment to appropriate black stroke patients at all healthcare institutions. Perhaps a national initiative and registry specifically targeting the utilization of stroke care in minorities should be developed. Policies, therefore, can be established to address the racial disparity in stroke care. As the authors have pointed out, there is the potential for improvement in stroke care to black patients. The medical centers in the southeast US area showed no racial disparity. They have set a good example for us. We should all learn from them.

It is time to implement stroke care practice improvement programs nationwide. Recently, both the American Stroke Association (ASA) and American Academy of Neurology (AAN) have taken the initiative in improving the access and management of stroke care. The ASA’s Operation Stroke Program specifically addresses increasing public knowledge of stroke, improving capacity for and response to stroke in healthcare systems, expanding access of care for those at risk of stroke, and promoting stroke prevention. The AAN’s Stroke Practice Improvement Network specifically examines the set of stroke care quality indicators, such as on-time delivery of IV tPA, DVT prophylaxis, swallowing evaluation, and warfarin for atrial fibrillation (R.H. Holloway, B.G. Vickrey, C. Benesch, J.A. Hinchey, and J. Bieber, unpublished data, 2001). While the need to implement stroke care improvement is urgent and the opportunity is the greatest, it is time for all of us to take the initiative so we can save more lives after stroke, regardless of ethnic origin.

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