Acute Stroke Care in Illinois
A Statewide Assessment of Diagnostic and Treatment Capabilities

Sean Ruland, DO; Philip B. Gorelick, MD, MPH; Michael Schneck, MD; Duk Kim, MD; Charity G. Moore, PhD; Sue Leurgans, PhD

Background and Purpose—To define areas for quality improvement in acute stroke care, a statewide assessment of preparedness for acute stroke diagnosis and treatment was carried out among 202 acute receiving hospitals in Illinois.

Methods—Medical directors or their designees completed a 1-page survey form that addressed availability of personnel, diagnostic technology, and organized programs for the treatment of acute stroke patients at their facility. In the analysis, acute care receiving hospitals in the Greater Chicago Metropolitan Area (GCMA) (Cook, Dupage, Lake, Will, and Kane counties) were compared with those in the remainder of the state.

Results—Of the acute care receiving hospitals, 91% responded to the survey. Overall, 99% had an emergency room receiving facility, 98.3% had a CT scanner, and slightly >70% had a recombinant tissue plasminogen activator (r-TPA) protocol. We found that 93.2% of residents in Illinois lived in a county with at least 1 acute care facility with an r-TPA treatment protocol. However, many of the non-GCMA receiving hospitals did not have a neurologist or a neurosurgeon available. Furthermore, specialized stroke diagnostic technology (eg, transcranial Doppler, diffusion-weighted MRI, MR angiography) was generally lacking in both the GCMA and non-GCMA, as were stroke community awareness programs and acute care stroke teams.

Conclusions—Stroke is a preventable and treatable disease. However, there are barriers to stroke care that are based on the availability of personnel, diagnostic technology, and programs. A systematic approach to the organization, implementation, and maintenance of services could improve outcome for stroke patients and reduce the public health burden of this deadly disease. (Stroke. 2002;33:1334-1340.)

Key Words: diagnosis ■ stroke, acute ■ treatment outcome

Stroke is a substantial public health concern.1 Stroke is the third leading cause of death and a major cause of disability and lost productivity. In the United States, there are approximately three quarters of a million new strokes each year.2 Interest in protecting “at-risk” brain tissue from acute ischemic stroke insult has given rise to clinical trials of thrombolytic and neuroprotective strategies. In 1996, the US Food and Drug Administration approved the first intervention for acute ischemic stroke, recombinant tissue-type plasminogen activator (r-TPA), a thrombolytic agent.3 Thus far, however, neuroprotectants have not proved to be an effective treatment for acute ischemic stroke.4 The emergence of r-TPA and a growing body of evidence that improved outcomes may occur in specialized stroke treatment settings5,6 make stroke an acute emergency comparable to myocardial infarction and trauma.

Several organizations in the United States such as the National Institute of Neurologic Disorders and Stroke, National Stroke Association, and the American Stroke Association have developed programs to educate the public, physicians, emergency medical services (EMS), and healthcare workers about proper identification and acute care for stroke. To define areas for quality improvement in the multifaceted system of acute stroke care, we assessed preparedness for acute stroke care by determining diagnostic and treatment capabilities in receiving hospitals throughout Illinois.

Subjects and Methods
All adult acute care inpatient medical facilities in Illinois were identified from the American Hospital Association Guide, 1999 to 2000. After approval by our local Institutional Review Board, a 1-page questionnaire adapted from Goldstein et al7 was sent to each local medical director (n=202). The questionnaire assessed the availability of equipment, programs, and services for stroke care (see Figure 1) and was completed by participants from December 1999 through May 2000. Medical directors at the acute inpatient medical facilities were instructed in a cover letter to forward the questionnaire to the individual in the respective institution judged most qualified to complete the information. A self-addressed, stamped envelope was enclosed to facilitate return of the questionnaire. For
Programs were broadly defined as patient care areas, administrative imaging (TTE), and transesophageal echocardiography (TEE).

Interventional neuroradiologists (33.3% versus 14.8%, P = 0.006) than those in the rest of the state (Table 1). Facilities with r-TPA protocols had a higher likelihood of having a neurologist (77.9% versus 61.2%, P = 0.036) or a neurosurgeon (60.3% versus 36.7%, P = 0.007). There was no difference in the availability of interventional radiologists according to the presence or absence of an r-TPA protocol (Table 2).

Personnel for Stroke Care
The GCMA acute care receiving hospitals had greater access to more neurologists (98.6% versus 56.5%, P < 0.001), neurosurgeons (81.9% versus 35.2%, P < 0.001), and interventional neuroradiologists (33.3% versus 14.8%, P = 0.006) than those in the rest of the state (Table 1). Facilities with r-TPA protocols had a higher likelihood of having a neurologist (77.9% versus 61.2%, P = 0.036) or a neurosurgeon (60.3% versus 36.7%, P = 0.007). There was no difference in the availability of interventional radiologists according to the presence or absence of an r-TPA protocol (Table 2).

Stroke Interventional Procedures
The GCMA had greater availability of intra-arterial thrombolysis (22.2% versus 8.3%, P = 0.014), carotid angioplasty (20.8% versus 3.7%, P < 0.001), and carotid stenting (20.8% versus 5.6%, P = 0.003) (Table 1). There were no differences in the availability of any of the above interventional procedures according to the presence or absence of an r-TPA protocol (Table 2).

Patient Care Units or Areas and Administrative Protocols
The GCMA had greater availability of MICUs (100% versus 85.2%, P < 0.001) and NICUs (12.5% versus 3.7%, P = 0.038) (Table 1). There were no significant differences across the state in access to emergency rooms, stroke units, and inpatient rehabilitation units. There were no significant differ-

Figure 1. Stroke research survey.

nonresponders, a second mailing and telephone contact were used to prompt the medical directors to make certain the questionnaire was completed and returned.

Data were collected from 183 of the 202 facilities surveyed (91%). These 183 hospitals were located in 76 of the 102 counties in Illinois. There were no hospitals within the boundaries of 24 counties. Two counties each had only 1 available facility that was among the nonresponders. On 3 occasions, 1 questionnaire was returned with responses for 2 facilities under the same administration and within close geographic proximity. Because it could not be determined which of these services were shared between facilities or duplicated, they were counted as separate for tabulation of the percentage of responders but as a single institution in the primary analysis.

The data were analyzed according to geographic region. Cook County and adjacent counties (Du Page, Lake, Will, and Kane) were combined to represent the Greater Chicago Metropolitan Area (GCMA). This region comprised 63.1% of the population of the state. Fisher’s exact tests were performed on the variables of interest to determine whether there were similar characteristics between the facilities of Cook County and the adjacent counties. Only 1 of the 28 variables studied (EMS prehospital stroke identification program) varied between Cook County (16%) and the facilities in adjacent counties (44%). No other differences were detected. Therefore, facilities in those 2 areas were combined into 1 group (referred to as GCMA) that was compared with the combined facilities in the remainder of the state when statistical comparisons were performed.

In a separate analysis, 3 major categories of resources were defined: personnel, diagnostic equipment, and programs. Personnel included 3 separate subcategories: neurologists, neurosurgeons, and interventional neuroradiologists. Diagnostic equipment included 11 subcategories: cranial CT, CT angiography (CTA), carotid duplex ultrasound, transcranial Doppler (TCD) ultrasound, MRI, MR angiography (MRA), diffusion-weighted MRI (DWI), perfusion imaging (PI), conventional cerebral angiography, transesophageal echocardiography (TEE), and transosophagal echocardiography (TEE). Programs were broadly defined as patient care areas, administrative organizational protocols or services, and educational services. Programs were further subdivided to include emergency rooms, medical intensive care units (MICUs), neurological intensive care units (NICUs), stroke units, inpatient rehabilitation units, stroke teams, r-TPA protocol for acute ischemic stroke, acute stroke care maps or pathways, anticoagulation clinics, community stroke awareness programs, and EMS prehospital stroke identification programs.

Fisher’s exact tests were used to compare proportions of facilities with specified characteristics or resources available in the geographic areas of interest, as well as according to the presence or absence of an r-TPA protocol (α = 0.05). Wilcoxon rank-sum tests were used to test differences in median numbers of resources available by location of facility. Spearman correlation coefficients (r) were calculated to investigate correlation by types of resources. Averages for the number of programs and amount of equipment were calculated for type of personnel available.

Results
Stroke Diagnostic Technology
The GCMA had a higher percentage of hospital facilities with the following stroke diagnostic technologies (Table 1): TEE (90.3% versus 45.4%, P < 0.001), conventional cerebral angiography (77.8% versus 40.7%, P < 0.001), CTA (59.7% versus 36.1%, P = 0.002), and TCD (38.9% versus 22.9%, P < 0.019). There were no differences across the state for the following diagnostic technologies (Table 1): CT, MRI, MRA, DWI, PI, carotid duplex ultrasound, and TTE. Facilities with r-TPA protocols had a higher percentage of CT (100% versus 93.9%, P = 0.019), DWI (29.8% versus 12.2%, P = 0.020), MRI (79.4% versus 59.2%, P = 0.008), and TCD (33.6% versus 16.3%, P = 0.027). There were no differences in the other variables in the diagnostic technology category according to the presence or absence of an r-TPA protocol (Table 2).
ences across the state for the availability of acute stroke teams, acute stroke care map or pathways, and r-TPA protocols (Figure 2) for acute ischemic stroke. Facilities with an r-TPA protocol had a higher availability of MICUs (93.9% versus 83.7%, \( P = 0.041 \)). There were no significant differences in the availability of NICUs, emergency rooms, inpatient rehabilitation units, and acute stroke care map or pathways according to the presence or absence of an r-TPA protocol (Table 2).

### Outpatient and Community Services

There were no significant differences across the state for the availability of anticoagulation clinics, community stroke awareness programs, and EMS prehospital stroke identification programs (Table 1). Furthermore, there were no differences in these variables according to the presence or absence of an r-TPA protocol for acute ischemic stroke (Table 2).

### Overview of State Capabilities

The total number of programs (emergency room, stroke unit, MICU, NICU, r-TPA protocol, stroke team, rehabilitation unit, acute stroke care map or pathway, community stroke awareness program, EMS prehospital stroke identification program, and anticoagulation clinic) ranged from 1 to 11. We found that 42.8% of facilities had ≥6 programs. The availability of diagnostic equipment (CT, CTA, carotid duplex ultrasound, TCD, MRI, MRA, DWI, PI, conventional cerebral angiography, TEE, and TTE) ranged from 0 to 11; 58.3% of facilities had ≥6. Fifty-six percent of facilities had ≥2 types of staff members (neurologist, neurosurgeon, or interventional neuroradiologist). For those facilities having only 1 type of staff member, 100% were neurologists.

When stratified by location, the GCMA had more equipment, staff, and all combined resources than the remainder of the state.
counties in Illinois (Table 3). Two counties (Sangamon and Peoria) contained facilities that had 24 and 25 of 25 combined resources, respectively. There were no significant differences in the number of programs provided by facilities in the GCMA and the rest of the state. Program availability was positively correlated with diagnostic equipment and staff. Additionally, diagnostic equipment was positively associated with the number of staff (Table 4).

More programs and equipment were present when more staff was available (Table 5). Further stratification by location showed that 32% of the GCMA facilities had all 3 types of personnel available compared with only 12% in the remainder of the state. Only 1% of the GCMA facilities had no personnel compared with 44% in the rest of the state.

**TABLE 2. Characteristics of Acute Care Medical Facilities in Illinois by r-TPA Protocol**

<table>
<thead>
<tr>
<th>Resource</th>
<th>r-TPA Protocol (n=131), %</th>
<th>No r-TPA Protocol (n=49), %</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke diagnostic technology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cranial CT</td>
<td>100.0</td>
<td>93.9</td>
<td>0.019*</td>
</tr>
<tr>
<td>CTA</td>
<td>45.8</td>
<td>44.9</td>
<td>1.000</td>
</tr>
<tr>
<td>Carotid duplex ultrasound</td>
<td>96.9</td>
<td>93.9</td>
<td>0.392</td>
</tr>
<tr>
<td>TCD</td>
<td>33.6</td>
<td>16.3</td>
<td>0.027*</td>
</tr>
<tr>
<td>MRI</td>
<td>79.4</td>
<td>59.2</td>
<td>0.008*</td>
</tr>
<tr>
<td>MRA</td>
<td>58.0</td>
<td>44.9</td>
<td>0.132</td>
</tr>
<tr>
<td>DWI</td>
<td>29.8</td>
<td>12.2</td>
<td>0.020*</td>
</tr>
<tr>
<td>PI</td>
<td>20.6</td>
<td>8.2</td>
<td>0.074</td>
</tr>
<tr>
<td>Conventional cerebral angiography</td>
<td>57.3</td>
<td>51.0</td>
<td>0.502</td>
</tr>
<tr>
<td>TTE</td>
<td>84.7</td>
<td>71.4</td>
<td>0.054</td>
</tr>
<tr>
<td>TEE</td>
<td>65.6</td>
<td>57.1</td>
<td>0.302</td>
</tr>
<tr>
<td>Personnel for stroke care</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neurologist</td>
<td>77.9</td>
<td>61.2</td>
<td>0.036*</td>
</tr>
<tr>
<td>Neurosurgeon</td>
<td>60.3</td>
<td>36.7</td>
<td>0.007*</td>
</tr>
<tr>
<td>Interventional neuroradiologist</td>
<td>23.7</td>
<td>18.4</td>
<td>0.547</td>
</tr>
<tr>
<td>Stroke interventional procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intra-arterial thrombolysis</td>
<td>15.3</td>
<td>10.2</td>
<td>0.473</td>
</tr>
<tr>
<td>Carotid stenting</td>
<td>13.7</td>
<td>6.1</td>
<td>0.198</td>
</tr>
<tr>
<td>Angioplasty</td>
<td>11.5</td>
<td>8.2</td>
<td>0.599</td>
</tr>
<tr>
<td>Patient care units/areas and administrative protocols</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ER</td>
<td>99.2</td>
<td>100</td>
<td>1.000</td>
</tr>
<tr>
<td>MICU</td>
<td>93.9</td>
<td>83.7</td>
<td>0.041*</td>
</tr>
<tr>
<td>NICU</td>
<td>8.4</td>
<td>4.1</td>
<td>0.519</td>
</tr>
<tr>
<td>Stroke unit</td>
<td>8.4</td>
<td>2.0</td>
<td>0.184</td>
</tr>
<tr>
<td>Inpatient rehabilitation unit</td>
<td>53.4</td>
<td>36.7</td>
<td>0.065</td>
</tr>
<tr>
<td>Stroke team</td>
<td>20.6</td>
<td>0.0</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Acute stroke care map/pathways</td>
<td>45.8</td>
<td>14.3</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Outpatient/community services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticoagulation clinic</td>
<td>13.0</td>
<td>12.2</td>
<td>1.000</td>
</tr>
<tr>
<td>Community stroke awareness programs</td>
<td>34.4</td>
<td>20.4</td>
<td>0.101</td>
</tr>
<tr>
<td>EMS prehospital stroke identification programs</td>
<td>31.3</td>
<td>24.5</td>
<td>0.463</td>
</tr>
</tbody>
</table>

n=180.

*Significant difference (P<0.05).

**Discussion**

We assessed the availability of diagnostic technology, personnel, interventional procedures, patient care units and administrative protocols, and community services for acute stroke care in Illinois using a survey of 91% of acute medical care facilities throughout the state. Our data show that nearly all institutions possess basic resources to evaluate acute ischemic stroke patients for r-TPA administration. Ninety-nine percent had an emergency room receiving facility, 98.3% had a CT scanner, and slightly >70% had a protocol for the administration of r-TPA. Overall, 93.2% of the residents of Illinois lived in a county that had at least 1 facility with an r-TPA protocol. However, there were substantial differences between the GCMA and the remainder of the state.
for availability of a staff neurologist (98.6% versus 56.5%). Furthermore, whereas all of the GCMA facilities (100%) and many of the non-GCMA facilities (85.2%) had an intensive care unit for post–r-TPA care, relatively fewer of the facilities in the GCMA (81.9%) or non-GCMA (35.2%) had a neurosurgeon on staff for potential post–r-TPA intracranial hemorrhage evacuation. Therefore, these facilities had the capacity to acutely treat the ischemic stroke patient with r-TPA but might have to arrange transfer to a nearby facility for aftercare, including potential intracranial hemorrhage evacuation. A 23-county acute stroke treatment network based in Peoria County has been established to facilitate r-TPA administration and transfer for aftercare when needed.8

Despite the fact that studies have shown the benefits of specialized units for stroke care,9 stroke units are uncommon in any region of the state. Although there is no consensus definition regarding stroke units and the responses were left to local interpretation, the relatively low proportion of stroke units reported spanned rural regions and the GCMA, with hospitals having larger average bed volumes supporting an overall deficiency of stroke units by any definition. Furthermore, smaller facilities in remote locations of the state may not admit a high enough volume of stroke patients to justify a dedicated unit.

Specialized diagnostic technology for acute stroke is generally lacking in Illinois (see Table 1). CTA (59.7% versus 36.1%), TCD (38.9% versus 22.2%), MRA (62.5% versus 49.1%), DWI (30.6% versus 21.3%), and PI (19.4% versus 15.7%) are not widely available in the GCMA and non-GCMA, respectively. However, TEE (90.3% versus 45.4%) and conventional cerebral angiography (77.8% versus 40.7%) are substantially more available in the GCMA than non-GCMA.

Finally, a major barrier to successful administration of r-TPA in acute stroke is a lack of recognition of symptoms of acute stroke by patients and early activation of “911” to summon the EMS. Previous studies have shown that community knowledge of stroke symptoms and risk factors is generally lacking.10 In Illinois, slightly >30% of centers had a stroke community awareness program, but only ~15% had a stroke team. In the United States, a template for development of these types of services at local hospitals is available through the American Stroke Association and National Stroke Association.11

A limitation of our study is that our questionnaire was simplistic to maximize response rate. It provided information on existent resources but lacked insight into the use of those resources (quality of care). Reliable information as to local experience and attitudes regarding r-TPA for acute ischemic stroke may not be consistent between the respondents and their local colleagues. Furthermore, the survey was sent to the medical director of each institution with the instruction to forward to the person most appropriate to provide the requested information for that institution. Therefore, it is impossible to identify the designated spokesperson (eg, emergency medicine physician, neurologist, medical director, or nurse). Prospective stroke registries are needed to accurately obtain this information.

In a recent publication of cross-sectional observational data (1997 to 1999) on the quality of care delivered to Medicare beneficiaries, Illinois ranked 46th of 52 states overall.12 For stroke quality indicators, warfarin was prescribed for patients with atrial fibrillation only 55% of the time, antithrombotic therapy was prescribed at discharge for patients with acute stroke or transient ischemic attack 80% of the time, and use of sublingual nifedipine for patients with acute stroke was avoided 92% of the time. As evidenced by our survey, Illinois is lacking in many facets of acute stroke care. Stroke teams, care maps, stroke units, and availability of neurologists are

### TABLE 4. Spearman Correlation Coefficients for Type of Resources Available

<table>
<thead>
<tr>
<th>Type of Resources</th>
<th>Equipment</th>
<th>Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program</td>
<td>0.52*</td>
<td>0.47*</td>
</tr>
<tr>
<td>Equipment</td>
<td>...</td>
<td>0.65*</td>
</tr>
</tbody>
</table>

*P<0.05.

### TABLE 3. Median, Mean, and Range Values for Number of Programs, Equipment, Staff, and Combined Resources Available by Geographic Location of Facility

<table>
<thead>
<tr>
<th>Total</th>
<th>GCMA</th>
<th>Non-GCMA</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programs</td>
<td>4</td>
<td>4</td>
<td>4.5</td>
</tr>
<tr>
<td>Equipment</td>
<td>6.5</td>
<td>6</td>
<td>6.4</td>
</tr>
<tr>
<td>Staff</td>
<td>2</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>All</td>
<td>12</td>
<td>12</td>
<td>12.4</td>
</tr>
</tbody>
</table>

![Figure 2. Survey results for r-TPA protocol.](image-url)
some of the major components that are missing in many hospitals throughout the state. Illinois is not the only state with gaps in preparedness to treat acute ischemic stroke. In North Carolina, Goldstein et al \(^7\) found that r-tPA treatment for acute ischemic stroke is available to most of that state’s population; however, stroke teams, care maps, stroke units, and rapid patient identification programs were used by few. Deficiencies in acute stroke diagnostic and treatment capabilities may be overcome. However, this will require a systematic approach to the organization and implementation of acute stroke care services. The low rate of r-tPA use in acute stroke patients in the United States (estimated at 1% to 3%) probably reflects a lack of effective organization and implementation of acute stroke care services. Novel local integrated stroke treatment networks such as the one developed by Wang et al \(^8\) in central Illinois may be a solution. City or statewide efforts to organize stroke care according to recommendations of the Brain Attack Coalition \(^6\) or Gordon’s \(^9\) template for comprehensive stroke care in Mississippi serve as another potential quality improvement solution. Such substantial initiatives, however, will need to be backed by city, statewide, or national legislative support to ensure that these programs are effectively organized, implemented, and maintained. Stroke is a major public health problem that can be treated and prevented. Billions of dollars are spent each year on stroke care in the United States; we now have the opportunity to lessen the burden of this disease by improving the quality of delivery of acute and follow-up stroke care. The essential tools to achieve the goal are available. Quality improvement in this area will be advanced by effective organization of acute stroke care services.

References

### Editorial Comment

**Assessment of Regional Acute Stroke Care**

Care rendered to stroke patients varies considerably across the United States. Numerous factors and barriers are responsible for this lack of uniformity. Rendering appropriate and timely care to stroke patients is an enormous challenge, in part due to (1) “patient-related” barriers such as lack of community education regarding early recognition of symptoms of impending or progressing stroke; lack of knowledge about available emergent therapies; and racial, socioeconomic, and ethnic factors; (2) “physician-related” barriers that pertain to attitudes and reticence on the use of tissue-type plasminogen activator (r-tPA) for ischemic stroke; (3) lack of a cohesive and multidisciplinary approach to the concept of “brain attack”; (4) and loose interpretation and lack of implementation of guidelines proposed by the National Institutes of Neurologic Disorders and Stroke, the National Stroke Association, and the American Stroke Association. These challenges are further compounded by lack of qualified personnel with expertise in stroke care and financial constraints for optimal diagnostic equipment and effective emergency transfer systems to hospitals. These important elements constitute significant barriers related to the health delivery system that may contribute to limiting effective and timely...
care of stroke patients. The combination of all these factors has a profound effect on rendering thrombolytic therapy to patients with ischemic stroke. Outside the setting of clinical trial, r-tPA is grossly underutilized in eligible patients,\textsuperscript{1,6} even in large, urban, community hospitals.

The accompanying article by Ruland et al\textsuperscript{7} in this issue of Stroke reports the availability of qualified personnel, diagnostic capabilities, and organized programs for acute stroke care delivery in the state of Illinois. The work provides valuable data regarding the state of care provided in this region and availability of resources, thus highlighting barriers toward providing services to stroke patients. The authors have utilized the questionnaire by Goldstein et al\textsuperscript{8} to report availability of equipment, programs, and services in a systematic fashion by dividing acute care hospitals into designated counties and teasing out differences in regional availability of these essential elements. It can be argued that the questionnaire utilized in this study is too simplistic in its approach. For example, “yes” or “no” questions provide information as to the availability of expertise or services to stroke patients, but the answers do not give insights into the quality of care rendered. Margin of error may be compounded by under- or overreporting. Whereas the American Stroke Association has proposed guidelines that define what constitutes a stroke unit, these guidelines are open to interpretation and heterogeneous implementation. For example, the study by Ruland et al\textsuperscript{7} does not provide an in-depth survey of the number of beds available or the level of acuity appropriate for an acute stroke unit among the institutions included in the survey. The existence of a protocol for thrombolytic therapy, or lack thereof, is only one of many necessary attributes that define the existence of a stroke program. Even more important than the existence of such a protocol are the implementation and manner in which the protocol is instituted.

Another important variable in rendering timely thrombolytic therapy is the comfort level, expertise, and attitudes of physicians (ED physicians, neurologists, primary care physicians, general internists). Similarly, care rendered to patients following thrombolytic therapy is provided by a varied physician group including general neurologists, general intensivists, or neurointensivists. Ruland et al\textsuperscript{7} have very nicely demonstrated and confirmed previous reports\textsuperscript{8} that there are regional statewide differences and a significant discrepancy in the resources among hospitals depending on their geographical location (ie, inside or outside a metropolitan area). The current study further confirms that acute stroke care in nonurban community hospitals does not follow published guidelines in the care of acute stroke patients.\textsuperscript{9} Such studies serve as a model that can be applied to other regions nationwide and may provide incentives for funding much needed stroke programs.

The study by Ruland et al highlights the interplay among factors that may provide explanation for underutilization of thrombolytic therapy in ischemic stroke patients. Some authors have proposed that strict guidelines be developed for designating specific institutions as stroke centers. Such centers would ideally possess key elements including acute stroke teams, stroke units, patient care protocols, and an integrated emergency response team.\textsuperscript{5} The opposing views are that this approach may cause a further decline in the use of thrombolytic therapy for eligible patients. If so, most hospitals could readily provide emergent care to patients with uncomplicated ischemic stroke. A compromise approach would be to institute thrombolytic therapy in the rural hospital and utilize effective transport methods, to allow completion of care at tertiary care centers.\textsuperscript{10}

While significant strides have been made in the care of stroke patients over the past 5 years, much remains in the implementation of standardized care of such patients, more so in the acute setting. Periodic regional neuroepidemiological surveys such as the one by Ruland et al and others\textsuperscript{8} are invaluable performance-improvement tools in taking into account the many variables that hinder optimal care provided to stroke patients.

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