Emergency Physician Treatment of Acute Stroke with Recombinant Tissue Plasminogen Activator: A Retrospective Analysis

RODNEY W. SMITH, MD, PHILLIP A. SCOTT, MD, ROBERT J. GRANT, MD, CARL R. CHUDNOFSKY, MD, SHIRLEY M. FREDERIKSEN, MS

Abstract. Stroke teams are advocated for the rapid treatment of patients who have acute ischemic stroke (AIS) with recombinant tissue plasminogen activator (rt-PA). An alternate model uses existing ED resources with specialist consultation as needed. **Objectives:** To evaluate the treatment of AIS with rt-PA in this alternate ED model. **Methods:** A retrospective observational review was performed of consecutive patients with AIS treated with rt-PA at four hospitals affiliated with an emergency medicine residency. Emergency physicians (EPs) were directly responsible for the treatment of all patients according to predefined guidelines. Records were evaluated from the implementation of the guidelines through December 15, 1997. **Results:** 37 patients with AIS received rt-PA. Mean age ± SD was 63 ± 16 years (range 22–87), with 25 (68%) male. Patients presented 67 ± 29 minutes after stroke onset. After ED arrival, they were seen by the EP in 14 ± 13 minutes, had CT in 46 ± 22 minutes, and were treated in 97 ± 35 minutes. Neurologist consultation occurred in the department for nine patients (24.3%), and by telephone for 14 (37.8%). Symptomatic intracerebral hemorrhage (ICH) occurred in four (10.8%, 95% CI = 0.8% to 20.8%). There were two deaths, neither associated with ICH. Neurologic outcome at discharge compared with presentation in survivors was normal for four patients (11.4%), improved for 16 (45.7%), unchanged for ten (28.6%), and worse for five (14.3%). **Conclusions:** In this analysis, EPs, with specialty consultation as required, successfully identified patients with AIS and delivered rt-PA with satisfactory outcomes. Important elements of this model include early patient identification, preestablished protocols, and rapid access to CT scanning and interpretation. **Key words:** cerebral infarction; cerebral ischemia; thrombolytic therapy; tissue plasminogen activator; emergency medicine. ACADEMIC EMERGENCY MEDICINE 1999; 6:618–625

IN DECEMBER 1995, the National Institute of Neurological Disorders and Stroke (NINDS) rt-PA Stroke Study Group published data demonstrating the efficacy of recombinant tissue plasminogen activator (rt-PA) for the treatment of acute ischemic stroke (AIS) when given within three hours of symptom onset.[1] Hospitals participating in the NINDS study developed teams of individuals with stroke expertise to emergently evaluate patients for entry into the trial, administer the drug, and arrange admission and follow-up.[2] Though labor-intensive, this approach provided the highest level of patient care and ensured compliance with strict inclusion and exclusion criteria defined in the study protocol. While composed primarily of neurologists, some of these stroke teams included specialists in emergency medicine (EM).

With the subsequent approval by the Food and Drug Administration (FDA) for this use of rt-PA, proponents have advocated the widespread development of "stroke teams," similar to those used in the study, as one mechanism to rapidly evaluate and treat emergency patients with symptoms of AIS. Advantages of such a strategy include a concentration of thrombolytic experience in acute stroke in a small number of individuals and the avoidance of monopolizing a single emergency physician's (EP's) time in treating a single patient. Disadvantages include the lack of availability of specialized staffing to provide around-the-clock coverage at many hospitals, thereby potentially limiting patient access to emergent thrombolysis.

An alternate approach, described here as the "ED model," uses EPs, with specialist consultation as needed, as the primary individuals responsible for evaluating patients and initiating thrombolytic

From St. Joseph Mercy Hospital, University of Michigan, Section of Emergency Medicine, Ann Arbor, MI (RWS); University of Michigan Medical Center, University of Michigan, Section of Emergency Medicine, Ann Arbor, MI (PAS); Foote Hospital, University of Michigan, Section of Emergency Medicine, Jackson, MI (RJG); Hurley Medical Center, University of Michigan, Section of Emergency Medicine, Flint, MI (CRC); and St. Joseph Mercy Hospital, Ann Arbor, MI (SMF).
Received October 29, 1998; revision received January 26, 1999; accepted February 9, 1999. Presented at the SAEM annual meeting, Chicago, IL, May 1998.
Address for correspondence and reprints: Rodney Smith, MD, St. Joseph Mercy Hospital, Room 1B95, 5305 Building, PO Box 995, 5301 Huron River Drive, Ann Arbor, MI 48106. Fax: 734-712-3275; e-mail: rosmith@msms.org

therapy when appropriate. This model uses many features of the "stroke team" approach but does not require the resources of a standing team to respond to the ED. Advantages include the use of personnel immediately available to the patient on ED arrival and the potential for widespread implementation in locations without stroke specialists physically present, but available via telephone for consultation. Potential difficulties of this model include rapidly and accurately identifying patients with AIS, minimal individual physician experience because of the small number of patients qualifying for rt-PA therapy, obtaining emergent cranial CT interpretation, and EP discomfort in being called upon to initiate therapy with a known risk of intracerebral hemorrhage (ICH).

This study reports data describing the treatment of AIS with rt-PA at four southern Michigan hospitals using this alternative ED model.

METHODS

Study Design. This was a retrospective analysis of patients with AIS treated with rt-PA at four hospitals affiliated with an EM residency. Institutional review board approval was obtained for this study.

Clinical Protocol. Following FDA approval, each of the hospitals affiliated with the University of Michigan and St. Joseph Mercy Hospital Emergency Medicine Residency Program developed treatment guidelines for AIS based on the NINDS study design and recommendations of the American Heart Association and the American Association of Neurology.[3,4] These hospital-specific guidelines call for rapid evaluation of ED patients presenting with symptoms of AIS by an EP. Emergent cranial CT scans were required for all patients and read by a radiology attending or resident to ensure patients had no CT exclusions for receiving thrombolytic therapy. Each hospital's guidelines included checklists to evaluate inclusion and exclusion criteria for treatment with rt-PA, guidelines for pre- and posttreatment blood pressure control, informed consent, dosing charts, and posttreatment intensive care unit (ICU) order sets. Educational efforts using lectures, inservices, and written material were directed at the physician, nursing, and ancillary staffs of EM, neurology, radiology, neurosurgery, and the ICUs depending on the resources used at a given hospital.

All EPs at participating hospitals had potential access to their local neurologists, as determined by each hospital's emergency coverage (on-call) schedule, for telephone or in-person consultation. Concurrent with the retrospective analysis period, a regional stroke team was participating in ongoing clinical trials investigating treatment of AIS beyond the three-hour treatment window used for rt-PA. This team originated in 1993 from EPs and neurologists at the University of Michigan Medical Center and St. Joseph Mercy Hospital with a research interest in acute stroke. Members of the team were available for consultation to EPs at the treating hospitals for patients being evaluated for rt-PA in the zero-to-three-hour time window. Local treatment guidelines, however, did not mandate consultation of any type prior to initiating therapy, and contact was at the discretion of the treating EP. Except for members of the stroke team, EP involvement in other acute stroke research was limited to identifying potential patients and notifying the stroke team.

All EPs treating patients with rt-PA were board-certified in EM. As faculty in an EM residency, they had access to conferences on the acute treatment of stroke as part of the didactic program of the residency, and had an opportunity to discuss the treatment of stroke at staff meetings during the development of the treatment guidelines. However, no specific educational or credentialing requirements were mandated.

Study Setting and Patient Population. The EDs participating in the clinical protocol described above are affiliated with the University of Michigan and St. Joseph Mercy Hospital Emergency Medicine Residency Program. St. Joseph Mercy Hospital is a 567-bed community teaching hospital and a major teaching affiliate of the University of Michigan School of Medicine. Annual ED census is 63,000. The University of Michigan Medical Center is an 840-bed academic teaching hospital with an annual ED volume of 55,000. Hurley Medical Center, located in Flint, Michigan, is a 500-bed urban teaching hospital affiliated with the EM residency and additional residencies in other major specialties. Annual ED census is 70,000. Foote Hospital is a 300-bed community hospital in Jackson, Michigan, staffed by EPs associated with the University of Michigan but without resident coverage. Annual ED census is 45,000.

Study Protocol. Pharmacy records were used to identify consecutively treated patients from the implementation of each hospital's treatment protocol, starting in March 1996, through December 15, 1997. These were cross-referenced with medical record searches using diagnosis-related group (DRG) codes related to ischemic stoke and thrombolytic use, a concurrent stroke log maintained by the regional stroke team, hospital ICU admission logs, and individual physician interviews to identify all ED patients treated with rt-PA for AIS.

A study physician reviewed each identified medical record to abstract data for spreadsheet en-

TABLE 1. Demographics of the Treated Patients

Total patients	37
Age—mean ± SD	63 ± 16 yr
Age—range	22–87 yr
Gender—male	25 (68%)
Race	
White	32 (86%)
Black	4 (11%)
Asian	1 (3%)
Arrived by EMS*	26 (70%)
Dominant hemisphere stroke	26 (70%)
History of hypertension	19 (51%)
History of prior stroke	4 (11%)
History of prior TIA†	3 (8%)
History of atrial fibrillation	7 (19%)
History of coronary artery disease	8 (22%)
History of diabetes	5 (14%)
Current cigarette smoking	10 (27%)
Current aspirin use	11 (30%)

*EMS = emergency medical services.
†TIA = transient ischemic attack.

try. Data sources included the patient's emergency medical services (EMS) ambulance record, the ED record and the hospital record. Subsequent rehabilitation and clinic notes were reviewed when available.

Data collected included information on patient demographics, medical and social history, evaluation times, physical exam findings, post-rt-PA therapy complications, length of stay, and outcome. Each patient's pretreatment cranial CT results were reviewed for potential treatment protocol violations. All posttreatment neuroimaging studies obtained were reviewed for hemorrhagic or other complications.

Data on the patient's pretreatment NIH Stroke Severity Score (NIHSSS) were recorded. The ED use of the NIHSSS occurred variably during the course of the study depending on the institution and individual physician as a result of ongoing educational programs. When available from the medical record, the NIHSSS was recorded in the database as documented. If no score was documented, the physician reviewer estimated the score retrospectively using five-point ranges (0–5, 6–10, 11–15, 15–20, ≥ 20) based on the neurologic exam documented in the medical record prior to treatment.

The presence of ICH was entered in the database if any posttreatment CT scan demonstrated intracerebral hematoma, hemorrhagic cerebral infarction (hemorrhagic transformation), intraventricular hemorrhage (IVH), or subarachnoid hemorrhage (SAH). Symptomatic ICH within 36 hours was considered related to the use of tissue plasminogen activator in accordance with the NINDS trial. This is defined as the presence of any ICH in a patient with a prior suspicion of hemorrhage or any decline in neurologic status.[5] All CT scans of patients with symptomatic ICH were reviewed by an independent neuroradiologist to confirm initial CT interpretation.

Both out-of-hospital and ED time data were collected. Out-of-hospital EMS times were obtained from run sheets for patients arriving via ambulance. ED time data collected included ED arrival as documented from initial triage, initial physician contact as documented from nursing and physician notes, time of cranial CT obtained from the CT image time stamp, and time of initiation of rt-PA bolus as obtained from the nursing record.

Data Analysis. Outcome data included length of stay and hospital disposition. In addition, physician investigators at each hospital made a qualitative determination of neurologic status at discharge compared with presentation; patients were classified as normal, improved, unchanged, worse, or deceased. Data were tabulated in a spreadsheet and descriptive statistics calculated. Confidence intervals for ICH rates were calculated based on the binomial distribution. Student's-t distribution was used to test significance of continuous variables.

RESULTS

A total of 37 patients received rt-PA over the study period. Demographic data for these patients are shown in Table 1. Mean age ± SD was 63.1 ± 15.8 years. Most patients were male and presented with right-sided symptoms, localizing to the dominant hemisphere. Stroke severity at the time of treatment is shown in Figure 1.

Out-of-hospital arrival time data were available from two hospitals, representing 24 patients (64.9%). Fifteen of these patients (62.5%) arrived by EMS. Average time from onset to ED arrival was 64 minutes for patients arriving by EMS compared with 84 minutes for those arriving by car ($p = 0.25$). Average time from onset to EMS dispatch was 17 minutes, with an average scene time of 17 minutes.

Complete times for ED evaluation and treatment were obtained in 34 records out of 37, and mean interval times are shown in Table 2. Two pa-

tients had CT scan obtained at an outside hospital before transfer to a treating facility and are not included in the CT time intervals. For one patient, the time seen by the EP was not available. The rt-PA bolus began an average of 97 minutes after arrival in the ED (range 38–171 minutes) and 166 minutes after stroke onset (range 61–220 minutes). Figure 2 shows the number of patients treated at various time intervals from symptom onset.

Neurology consultation occurred in the ED for nine patients (24.3%) and by telephone for 14 (37.8%). No neurology consultation could be identified for the remaining 14 patients (37.8%). Of the nine in-person consultations, seven occurred at the university teaching hospital where the neurology service was automatically consulted according to local treatment guidelines. Neurology residents provided the majority of university teaching hospital consultations, but the attending EP was directly responsible for drug administration.

No records exist on telephone consultation with the regional stroke team, although polling of team members suggests EPs contacted the team prior to treatment in a majority of cases. No patient treated with rt-PA for acute stroke within zero to three hours was personally evaluated as a consult by a stroke research team member prior to initiation of therapy. Of note, the regional stroke team was composed primarily of EPs. These physicians did encounter acute stroke patients in the course of their routine ED staffing. A total of six patients (16.2%) were treated by EP members of the regional stroke team during scheduled shifts in the ED.

Seven patients (18.9%) had treatment protocol violations identified, all relating to administration of rt-PA beyond the 180-minute window, with violations ranging from 1 to 40 minutes. No patient in this group experienced a hemorrhagic complication.

A total of four patients (10.8%, 95% CI = 0.8% to 20.8%) developed symptomatic ICH within 36 hours of treatment with rt-PA. Two had parenchymal hemorrhages; review of the pretreatment cranial CT scans identified one with early infarct signs (slight hypodensity and effacement of cortical sulci), but no evidence of mass effect. Two patients had atypical hemorrhages compared with published studies using rt-PA; their CT scans are shown in Figure 3 (Patients A and B).

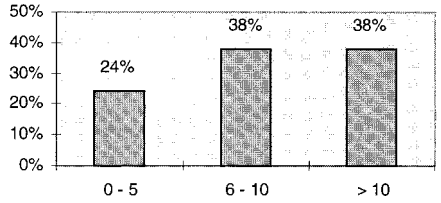

Figure 1. NIH Stroke Scale of treated patients.

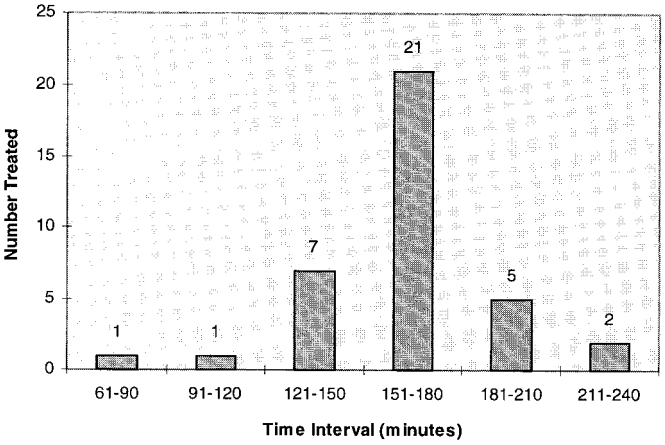

Figure 2. Distribution of treatment time intervals.

Patient A presented with expressive aphasia and right face and arm weakness. After treatment these deficits partly improved. Approximately 8 hours posttreatment, the patient's aphasia returned. A repeat head CT was obtained revealing an isolated IVH. No further imaging was performed, and the patient's aphasia and weakness were noted improved at the time of discharge.

Patient B presented with dysarthria and right hemiparesis. Symptoms initially improved follow-

TABLE 2. Time Intervals (Min) for Evaluation and Treatment of Patients with rt-PA*

Hospital Type	*n* (%)	Onset to ED	Onset to rt-PA	Door to Physician	Door to CT	Door to rt-PA
Community teaching	17 (46.0%)	66 ± 26	163 ± 35	16 ± 16	51 ± 22	97 ± 34
University teaching	7 (18.9%)	85 ± 43	174 ± 12	6 ± 6	40 ± 14	89 ± 43
Urban teaching	6 (16.2%)	56 ± 13	183 ± 22	18 ± 14	56 ± 27	127 ± 15
Community	7 (18.9%)	63 ± 28	144 ± 20	14 ± 11	30 ± 15	81 ± 32
Combined	37 (100.0%)	67 ± 29	165 ± 29	14 ± 13	46 ± 22	97 ± 35

*rt-PA = recombinant tissue plasminogen activator. Onset to ED = time from symptom onset to patient presentation; Onset to rt-PA = time from onset of symptoms to treatment with rt-PA; Door to physician = time from ED presentation to evaluation by emergency physician; Door to CT = time from ED presentation to CT scan; Door to rt-PA = time from ED presentation to treatment with rt-PA.

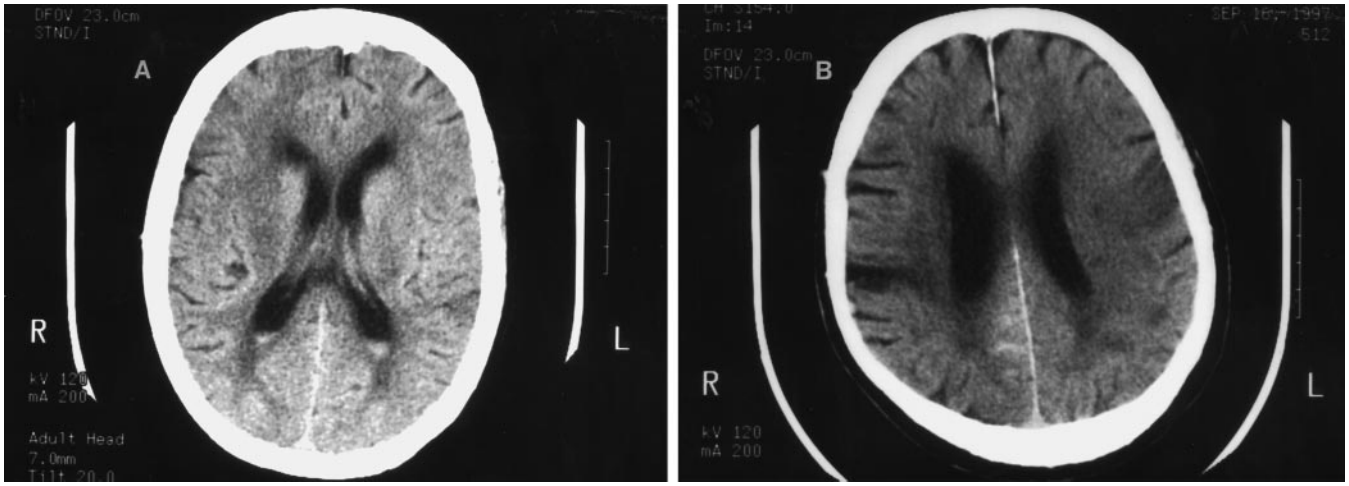

Figure 3. CT scans of two of the patients with symptomatic intracerebral hemorrhage. Patient **A** has an isolated, small intraventricular hemorrhage. Patient **B** has a left-sided ischemic stroke and a small, isolated subarachnoid hemorrhage on the right.

ing rt-PA administration, but returned to presenting baseline approximately 10.5 hours after treatment. A repeat CT scan demonstrated a left hemisphere ischemic stroke and an isolated right SAH. A third CT scan the following day remained unchanged. At discharge the patient was found to have both improved weakness and dysarthria compared with presentation.

An additional two patients (5.4%, 95% CI = 0% to 12.7%) had asymptomatic ICH within 36 hours of treatment identified on routine CT scans obtained prior to the initiation of anticoagulation therapy. Two patients with late ICH were identified, one each on hospital day 3 and day 5, both occurring in patients receiving anticoagulation therapy for cardioembolic stroke.

Two patients died prior to discharge, neither believed related to rt-PA use. The first had a severe stroke (NIHSSS = 24) on presentation and died from herniation due to cerebral edema on day 6. Posttreatment CT scan had shown no evidence of ICH. The second death occurred on hospital day 21 in a patient awaiting nursing home placement, as a result of a presumed pulmonary embolus.

Neurologic outcome in survivors (35) at the time of discharge compared with presentation was determined as normal for four patients (11.4%), improved for 16 (45.7%), unchanged for ten (28.6%), and worse for five (14.3%). Fifteen patients (43%) were discharged to home and 15 (43%) to a rehabilitation facility. Three patients were discharged to a nursing home, one patient was transferred to another hospital, and the disposition is unknown for one patient. Length of stay for survivors averaged 8.1 ± 6.5 days. One treated patient had a final clinical diagnosis at discharge of suspected complex migraine.

DISCUSSION

The demonstration of efficacy of rt-PA for acute ischemic stroke requires a radical change in the approach to stroke patients in the emergency setting. Recently, the NINDS has published guidelines calling for the evaluation and treatment of appropriate patients with AIS within 60 minutes of hospital arrival.[6] A concerted effort on the part of a variety of providers is needed if treatment is to begin within this time interval.

Such an effort involves improved community education on the signs and symptoms of AIS and the appropriate early use of 911 systems to access medical care.[7] Upon patient entry into the EMS system, ambulance personnel must recognize the features of a stroke in progress, minimize transport time, and provide early notification to the receiving hospital of a potential acute stroke patient. On arrival to the ED, systems must be in place to rapidly evaluate patients for thrombolytic therapy eligibility.

Physicians making the treatment decision must recognize and reliably diagnose stroke and be familiar with the risks and benefits of treatment in order to adequately inform the patient and family members. The stroke team model is a proven approach to achieving these goals and facilitating rapid treatment of stroke patients.[2,8–10]

The ED model described in this study is an alternative approach based on current ED systems used to deliver thrombolytic drugs in patients with acute myocardial infarction (AMI).[11] Patients with chest pain are evaluated by an EP who determines patient eligibility for thrombolytic treatment and initiates therapy. The availability of specialty consultation as needed is critical in this model, al-

though it should not slow the initial approach to the patient. Consultation is obtained in cardiac cases where the diagnosis is in question, an alternative therapy may provide greater benefits, or for individual physician preference.

A similar stroke therapy delivery system would allow patients with AIS access to thrombolytic treatment in hospitals not affiliated with dedicated stroke teams. To our knowledge, this is the first published series of patients with AIS treated with rt-PA using an ED model and the data suggest a promising initial effort in a variety of ED practice settings.

Time intervals reported in this series compare favorably with those reported by Chiu et al., in a series of 30 patients treated in Houston, TX, using a stroke team model in operation since 1992.[12] Most of those patients (93%) were treated by a member of the stroke team, which included four neurology faculty members, three neurology fellows, and a nurse coordinator. Their patients presented to the ED, on average, 10 minutes earlier than those in the present study (57 minutes vs 67 minutes). This difference may reflect shorter transport times in an urban setting, and the time is similar to the 56-minute presentation time for the urban teaching hospital in this series. Time to CT averaged 41 minutes and mean time to treatment was 100 minutes in their series, compared with 47 and 97 minutes in this series. Chiu et al. also found protocol violations for treatment after 180 minutes in 10.0% (3/30) compared with 18.9% in this study.

Our experience suggests that deadlines are an important element in the time to treatment. Twenty-one of the 30 patients (70.0%) treated within three hours of stroke onset in this series received rt-PA within the last half-hour of the allotted time. Tilley et al. reported the results of a total quality management process related to the NINDS rt-PA study in an attempt to reduce delays in treatment.[13] They demonstrated overall time from ED presentation to treatment of 67 to 70 minutes. However, the time to treatment was 52 to 58 minutes in those patients randomized to treatment within 90 minutes, compared with 78 to 86 minutes in patients randomized to receive rt-PA between 90 and 180 minutes.

The 97-minute door-to-door treatment time reported here is longer than the 60-minute goal recommended by the NINDS.[6] This may reflect EP uncertainty with a new therapy, well-meaning efforts to check and recheck all treatment criteria prior to initiation of a potentially hazardous drug, system inefficiencies, and time taken to obtain consultation and to address medicolegal concerns with regard to hemorrhagic complications.

Emergency physicians appear to consult in a majority of cases prior to initiation of rt-PA therapy in AIS, with a minimum of 62% of patients having some form of consultation documented. This figure may extend higher due to the possibility of incomplete documentation, consultation with the regional stroke team by phone rather than with a neurologist, and treatment by stroke team members working a routine shift in the ED. The ability for neurologists and stroke specialists to offer direction in the acute setting without a physical presence is suggested by the finding that 61% of all consults occurred via phone.

In the analysis of this model, EPs with specialty consultation as clinically indicated, identified AIS with similar diagnostic accuracy as reported in other studies. The one patient with a discharge diagnosis other than AIS was a 40-year-old female presenting with sudden onset of hemianopsia who denied any history of headache in the ED. Neurologic consultation was obtained by phone prior to rt-PA treatment. The patient's visual deficits subsequently normalized and the discharge diagnosis was listed as suspected complex migraine; no follow-up MRI had been obtained to rule out AIS. This 2.7% (95% CI = 0.0% to 7.1%) misdiagnosis rate compares favorably against studies using a stroke team approach. Chiu et al. found one patient in this series with a final diagnosis of suspected psychogenic hemiparesis.[12] In the NINDS trial, 1% of all patients treated had a final neurologic diagnosis other than stroke.[14] In one retrospective series, comparing the admitting diagnosis of EPs at a large urban teaching setting that had a comprehensive stroke program with the discharge diagnosis, the EPs correctly identified 346 of 351 patients with ischemic stroke or TIA (sensitivity 98.6%, specificity 99.8%).[15]

The most feared complication associated with thrombolytic treatment of AIS is ICH. The rate of symptomatic ICH attributable to the use of rt-PA in the present series (10.8%) was greater than that reported in the NINDS trial (6.4%) or the Houston series (6.7%).[1,12] The number of patients in the series reported here is small, however, and the confidence interval extends well below 6%. This number may also be high due to a conservative approach on the part of the physician chart reviewers to retrospectively "find" a symptom to associate with a known ICH. In addition, two of the four ICH patients had atypical hemorrhages, one, an isolated SAH, and the second, an isolated IVH. In the NINDS trial, four of 20 hemorrhages occurred outside the distribution of the stroke, but no case of isolated SAH or IVH was reported.[5] In the GUSTO-1 trial of thrombolysis for AMI, 1.2% of the 244 cases of ICH were isolated IVH, though again, no case of isolated SAH was identified.[16] No deviation from treatment protocols was identified in

any patient with ICH, and the significance of these atypical ICHs remains unclear.

Encouragingly, no fatality associated with ICH was found at discharge in the series reported here, whereas the fatality rates due to ICH at 90-day follow-up in the NINDS trial and in the Houston trial were 45% and 50%, respectively.[1,12] This difference may be due to the small numbers in the series above, and may reflect obvious differences in follow-up durations.

Long-term outcome data were not obtained, and no standardized outcome measures such as the Barthel Index or the Modified Rankin Scale were available in the medical record, limiting comparisons to published trials. At discharge, however, 51% (19/37) of the patients were qualitatively improved or normal, 24% (9/37) were unchanged from presentation, and 20% (7/20) had worsened or died.

Limitations and Future Questions

This study is limited by all weaknesses associated with retrospective cohort studies. The potential for exclusion of patients with AIS treated with rt-PA exists, although using the search modality described minimized this possibility. Physician reviewers were dependent on the availability and quality of the data and evaluations made both in the ED and subsequent hospital setting. Only patients actually treated with rt-PA were included in this study. It is possible that patients with AIS eligible for treatment were not identified by the EP or were identified but not treated due to delays in evaluation or physician reluctance.

All of the participating hospitals had 24-hour availability of radiology interpretation of CT scans, either by a radiology attending or resident. This level of support may not be duplicated at other hospitals. Comparisons of EP interpretation of cranial CT scans with radiologist interpretations found nonconcordance in 38.7%, with potentially clinically significant misinterpretations in 24.1%.[17] EPs demonstrated improved performance, reducing major missed findings to 2.8% with no instance of clinically significant patient mismanagement, following an abbreviated educational session in a follow-up study.[18] In addition, teleradiology technology potentially makes specialist interpretation available for any appropriately equipped hospital.

With institution of time-to-treatment goals and a continuous quality management process, a future study might examine whether the goal of treatment within one hour of presentation can be achieved using either the ED model or the stroke team model. Notably, subgroup analysis of the NINDS study data showed no correlation between outcome and time to treatment.[19] Further study to identify such a relationship would be useful if these time-to-treatment goals are to be widely disseminated.

Finally, the impact of the presence of a regional stroke team cannot be gauged. Though the team did not directly evaluate treated patients, their availability for phone consultation and ongoing regional stroke education and research efforts may be presumed to have raised overall EP awareness on the emergent treatment of AIS.

Conclusion

Emergency physicians, in this retrospective analysis across a variety of practice settings, successfully identified patients with AIS eligible for IV thrombolysis and delivered rt-PA therapy with satisfactory outcomes. Important elements of this system include early identification of AIS patients, use of checkoff treatment protocols to determine patient eligibility for thrombolytic therapy and guide early management; rapid access to cranial CT scans and their interpretation; and the availability of consultation, by phone or in person, with experts familiar with the use of this treatment as clinically required. Continued data collection is warranted to evaluate time-to-treatment goals and to monitor rates of ICH, accuracy of patient selection, and ultimate outcome.

This ED model potentially extends patient access to emergent thrombolysis in AIS at institutions that do not have access to the personnel required for implementation of a stroke team model.

References

1. NINDS rt-PA Stroke Study Group. Tissue plasminogen activator for acute ischemic stroke. N Engl J Med. 1995; 333: 1581–7.
2. NINDS rt-PA Stroke Study Group. A systems approach to immediate evaluation and management of hyperacute stroke. Experience at eight centers and implications for community practice and patient care. Stroke. 1997; 28:1530–40.
3. Adams HP, Brott TG, Furlan AJ, et al. Guidelines for thrombolytic therapy for acute stroke: a supplement to the guidelines for the management of patients with acute ischemic stroke. Stroke. 1996; 27:1711–8.
4. Anonymous. Practice advisory: thrombolytic therapy for acute ischemic stroke—summary statement. Report of the Quality Standard Subcommittee of the American Academy of Neurology. Neurology. 1996; 47:835–9.
5. NINDS rt-PA Stroke Study Group. Intracerebral hemorrhage after intravenous rt-PA therapy for ischemic stroke. Stroke. 1997; 28:2109–18.
6. Bock BF. Response system for patients presenting with acute stroke. In: Anonymous. Proceedings of a National Symposium on Rapid Identification and Treatment of Acute Stroke. Bethesda, MD: National Institute of Neurological Disorders and Stroke, 1997, pp. 55–6.
7. Barsan WG, Brott TG, Broderick JP, Haley EC, Levy DE, Marler JR. Urgent therapy for acute stroke. Effects of a stroke trial on untreated patients. Stroke. 1994; 25:2132–7.
8. Zweifler RM, Drinkard R, Cunningham S, Brody ML, Rothrock JF. Implementation of a stroke code system in Mobile, Alabama. Diagnostic and therapeutic yield. Stroke. 1997; 28:

981–3.
9. Gomez CR, Malkoff MD, Sauer CM, Tulyapronchote R, Burch CM, Banet GA. Code stroke. An attempt to shorten inhospital therapeutic delays. Stroke. 1994; 25:1920–3.
10. Bratina PL, Greenberg L, Pasteur W, Grotta JC. Current emergency department management of stroke in Houston, Texas. Stroke. 1995; 26:409–14.
11. National Heart Attack Program Coordinating Committee. Emergency department: rapid identification and treatment of patients with acute myocardial infarction. Ann Emerg Med. 1994; 23:311–29.
12. Chiu D, Krieger D, Villar-Cordova C, et al. Intravenous tissue plasminogen activator for acute ischemic stroke. Feasibility, safety, and efficacy in the first year of clinical practice. Stroke. 1998; 29:18–22.
13. Tilley BC, Lyden PD, Brott TG, et al. Total quality improvement method for reduction of delays between emergency department admission and treatment of acute ischemic stroke. Arch Neurol. 1997; 54:1466–74.
14. Grotta JC. Should thrombolytic therapy be the first-line treatment for acute ischemic stroke? t-PA—the best current option for most patients. N Engl J Med. 1997; 337:1310–3.
15. Kothari RU, Brott TG, Broderick JP, Hamilton CA. Emergency physicians. Accuracy in the diagnosis of stroke. Stroke. 1995; 26:2238–41.
16. Gebel JM, Sila CA, Sloan MA, et al. Thrombolysis-related intracranial hemorrhage. A radiographic analysis of 244 cases from the GUSTO-1 Trial with clinical correlation. Stroke. 1998; 29:563–9.
17. Alfaro D, Levitt MA, English DK, Williams V, Eisenberg R. Accuracy of interpretation of cranial computed tomography scans in an emergency medicine residency program. Ann Emerg Med. 1995; 25:169–74.
18. Levitt MA, Dawkins R, Williams V, Bullock S. Abbreviated educational session improves crania computed tomography scan interpretations by emergency physicians. Ann Emerg Med. 1997; 30:616–21.
19. NINDS rt-PA Stroke Study Group. Generalized efficacy of t-PA for acute stroke. Subgroup analysis of the NINDS t-PA stroke trial. Stroke. 1997; 28:2119–25.

Instructions for Contributors to *Commentaries*

On occasion, the *Academic Emergency Medicine* Editorial Board asks individuals with special expertise to develop commentaries (editorials) regarding an article published in *AEM*.

AEM manuscript submission requirements correspond with the "uniform requirements for manuscripts submitted to biomedical journals" (JAMA. 1997; 277:927–34). Solicited commentaries should be sent to the SAEM Editorial Office (address below) and should be accompanied by a copyright and author disclosure form that has been reviewed and signed and an electronic copy on a computer disk. Any word processing program is acceptable for this submission; the type of processing program should be indicated on the label of the disk.

Send three hard copies and the electronic version of the commentary to: *Academic Emergency Medicine*, Society for Academic Emergency Medicine, 901 North Washington Avenue, Lansing, MI 48906. Phone: (517) 485-5484; fax: (517) 485-0801; e-mail: saem@saem.org.

Commentaries should be no longer than ten double-spaced, single-sided, typewritten pages. Appropriate references should be incorporated, but should not exceed ten references. Tables and figures are also acceptable for commentaries, although they are rarely submitted.

The commentary is generally solicited to respond to or reflect upon a specific article that will be published in the same issue of *AEM*. Commentary authors may wish to point out strengths and weaknesses of the study that is under consideration, but should remember that significant peer review has already occurred. Instead, the commentary authors might wish to expand on the concept or message that is being demonstrated in the work they are reviewing. Commentary authors are also selected because of their noted expertise in the area under consideration. It is therefore appropriate for authors to bring their expertise into play as they discuss the article.

Commentaries do not require any specific formatting. Written permission must be obtained if the author decides to reproduce figures or tables from any other publications. The sources of reproduced material must be acknowledged in the manuscript.

Commentaries that include material under consideration by another publication and/or duplicate materials published or submitted elsewhere by the authors cannot be considered. Copies of similar manuscripts under review or published elsewhere should be provided when submitting the manuscript for consideration as a commentary.

Any specific questions regarding these guidelines offered for authors of commentaries can be directed to the Editor-in-Chief of *Academic Emergency Medicine*, Michelle Biros, MS, MD, at (612) 347-5683.