Code Stroke
An Attempt to Shorten Inhospital Therapeutic Delays

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Background and Purpose Significant delays often occur during the treatment of patients with acute stroke. Some of those delays occur in the hospital. We attempted to shorten inhospital treatment intervals by creating a rapid-response system, similar to that available for cardiac arrest, that would allow the stroke team to be available within a few minutes to care for stroke victims.

Methods We connected all beepers (pocket pagers) of stroke team members to a common access number and instructed the emergency staff to activate that number immediately upon arrival of a stroke victim. We monitored the response time and treatment interval for patients who were treated after this system was activated (Code Stroke patients) during the first 3 months of its availability and compared the results to those of patients seen for similar reasons during the study period but without the use of Code Stroke (control patients).

Results A total of 12 Code Stroke patients were available for analysis, representing 12% of all patients (n=98) seen in the emergency department for ischemic stroke during the study period. The remaining 86 patients constituted the control group. The mean time to evaluation of a Code Stroke patient by a stroke team member was 4.8 minutes (range, 2 to 7 minutes), and the mean time to treatment institution was 30 minutes (range, 10 to 120 minutes). There were significant differences between the consultation intervals in the two groups (P<.05). There was only a trend of a difference between treatment institution intervals (P=.06).

Conclusions It is possible to shorten inhospital treatment delays by instituting rapid-response systems within individual institutions. (Stroke. 1994;25:1920-1923.)

Key Words • cerebral ischemia • cerebrovascular disorders • emergency service, hospital • hospitalization

Stroke is the third leading cause of death in the United States after heart disease and cancer, as well as the most common cause of disability in adults.1 Emergency evaluation and treatment of patients with stroke, however, have been somewhat disorganized. It would seem reasonable for a condition with such potentially devastating effects to be given a high priority in terms of emergency management. This has not been the case in the past, and there is increasing evidence that significant delays occur during the treatment of stroke patients.2-7 We describe a prototype system designed to decrease delays that occur in the inpatient phase of stroke treatment, and we present our preliminary experience with its implementation.

Subjects and Methods
The Code Stroke System
We identified all individuals in the Department of Neurology at Saint Louis University Health Sciences Center who were involved in the care of patients with acute ischemic stroke. This group of individuals constituted the stroke team and included four attending neurologists, two cerebrovascular and neurointensive care fellows, four neurology residents, and one clinical nurse specialist. The pocket pagers (ie, beepers) of all of these individuals were connected as a network to one common access number (Figure). This number was provided in addition to the number already assigned to each beeper. When the common access number is dialed, the system is activated and all interconnected beepers are triggered simultaneously. The hospital switchboard operators, who were involved in the design of the system, were instructed when and how to proceed in getting the system to work. We then established a priority algorithm that would guarantee a response with a maximum delay of 10 minutes. This algorithm included stratification of the responsibility of answering the calls (Figure). Essentially, hospital personnel were instructed to call the four-digit number every 5 minutes until someone answered.

Concept Dissemination
We personally contacted the attending physicians in the emergency department and notified them of the existence of this rapid-response system as well as of our willingness to respond within 10 minutes of its activation. We provided all emergency department staff (physicians and nurses) with laminated cards that contained instructions on how to activate the system and what to do for the patient until a member of the stroke team arrived. Finally, we sent letters of information to all attending physicians on staff at Saint Louis University Hospital and provided them with similar laminated cards.

Preliminary Data Collection
Once the Code Stroke system was made available, we allowed a period of 30 days before any data were collected. We then monitored a period of 12 weeks (November 1, 1993, to January 31, 1994), during which we identified all patients for whom the Code Stroke system had been activated (Code Stroke group). Specifically, we noted the times at which the following occurred: onset of symptoms (T0), arrival at our emergency facility (T1), Code Stroke system activation (Tcode), evaluation by the Code Stroke team (T2), and institution of...
treatment ($T_n$). We then measured the intervals between each of these temporal markers and compared them with similar interval measurements, obtained retrospectively, for patients seen without the activation of Code Stroke for possible stroke during the study period (control group). This comparison was performed by ANOVA for unpaired groups using a microcomputer system and dedicated software (KWIKSTAT, Mission Technologies). In the control group, instead of $T_{code}$ we used the time at which consultation was requested by the emergency department staff.

**Results**

A total of 12 patients constituted the Code Stroke group. They included 5 women and 7 men, and their ages ranged from 7 to 86 years (mean, 65 years). They represented 12% of all patients ($n=98$) seen in our emergency department during the study period for the possibility of stroke. The remaining 86 patients constituted the control group. They included 40 women and 46 men, and their ages ranged from 45 to 82 years (mean, 61 years). The Table summarizes the data related to the intervals between the temporal markers noted above. These include the interval between onset of symptoms and arrival at our facility ($T_o - T_a$); the interval between arrival and the activation of Code Stroke ($T_a - T_{code}$); the interval between the activation of Code Stroke and the time a member of the stroke team arrived at the bedside ($T_{code} - T_b$); and finally, the time between the beginning of the stroke team’s evaluation and the institution of what was considered definitive acute treatment ($T_b - T_n$). In addition, the Table includes summary data about similar intervals in the control group. There are definite differences between the intervals in the two groups that reflect requests for consultation and assessment by the stroke team ($P<.05$). There is only a trend that suggests treatment implementation is affected by Code Stroke ($P=.06$).

**Discussion**

The care of individuals who suffer cardiac arrest is expeditious, whether or not the event occurs in the hospital. In general, a team is summoned to the bedside when a “code” is called. Along the same lines, it is becoming increasingly obvious that the access of stroke patients to definitive care must also be expedited. The concept of treating strokes as “brain attacks” is gaining popularity; as it does, identification of unnecessary delays is at the heart of the need for a systematic and thorough approach to the care of stroke victims. The results of our study, although preliminary, have several important implications.

First, it is clear that the availability and willingness of a group of specialists, combined with the application of a fail-safe alert system such as Code Stroke, result in the availability of expert care to the patient within a very short period of time, effectively less than 5 minutes. This availability is important not only to patients who are rushed into the emergency department but also to patients who develop strokes while already in the hospital for other reasons. This availability also results in the rapid institution (ie, an average of 30 minutes) of what is judged to be definitive treatment (Table). It is not our intention to discuss the efficacy of any of the therapeutic modalities used but rather to report the feasibility of rapid application of any form of intervention considered appropriate for the specific circumstances. Therefore, in the Table, the column on the right could instead list medications that are part of research studies, or in the future it could include those that eventually may be approved for the treatment of stroke. Among other things, this underscores the potential impact that a system such as Code Stroke could have on the recruitment of patients into investigational acute stroke protocols. It is not surprising that treatment modalities that required the performance of invasive or surgical procedures (ie, patients 5, 9, and 11) could not be applied as rapidly. This difference is of practical importance, and it will have to be taken into account in the future implementation of treatment algorithms.

The second issue raised by the results of this project is that the final diagnoses of two of the patients were not strokes: one had a hypertensive crisis, and another had metastatic brain cancer with seizures. Our original goal was to establish a rapid-response system that was fail-safe. The fact that Code Stroke was activated in instances in which the patients had not suffered strokes may at first appear counterproductive but actually signals that the system does not require the activating person to be sure about the diagnosis. In the past, we have reported the delays that occur in the emergency department between the arrival of the patient and the request for expert consultation. The present study shows that such delays continue to occur, as reflected by the control group measurements. These delays result partly from the time spent in “making sure” the patient has had a stroke. The differential diagnosis of acute stroke is based on a list of conditions that are all neurological; therefore, having neurologists decide whether the patient has suffered a stroke is probably a more efficient use of time. We believe that the Code Stroke system has a neurological triage capability that would further shorten unnecessary delays. This situation is analogous to that in which patients present to emergency department.
Summary of Patients Seen Directly Due to Activation of Code Stroke During the Study Period and Comparison With Similar Intervals in the Control Group

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age, y</th>
<th>Sex</th>
<th>T₀⁻ₐ</th>
<th>Tₛ⁻ₐ</th>
<th>Tₐ⁻ₐ</th>
<th>Tₐ⁻ₑ</th>
<th>Tₑ⁻ₑ</th>
<th>Tₑ⁻ₑ</th>
<th>Final Diagnosis</th>
<th>Treatment</th>
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<tr>
<td>1</td>
<td>60</td>
<td>M</td>
<td>35</td>
<td>59</td>
<td>7</td>
<td>10</td>
<td></td>
<td></td>
<td>Cbl</td>
<td>IV heparin</td>
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<tr>
<td>2</td>
<td>78</td>
<td>M</td>
<td>60</td>
<td>22</td>
<td>5</td>
<td>15</td>
<td></td>
<td></td>
<td>HTN crisis</td>
<td>IV nitroprusside</td>
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<tr>
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<td>73</td>
<td>F</td>
<td>184</td>
<td>44</td>
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<td></td>
<td>Cl (MCA)</td>
<td>IV heparin</td>
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<td>270</td>
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<td>6</td>
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<td></td>
<td>BI</td>
<td>IV heparin</td>
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<tr>
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<td>M</td>
<td>60</td>
<td>180</td>
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<td></td>
<td>Cl (MCA)</td>
<td>IA papaverine</td>
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<tr>
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<td>63</td>
<td>5</td>
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<td></td>
<td>MET CA</td>
<td>Intubation</td>
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<td>420</td>
<td>10</td>
<td>4</td>
<td>11</td>
<td></td>
<td></td>
<td>VB TIA</td>
<td>Plasma expansion</td>
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<tr>
<td>8</td>
<td>78</td>
<td>F</td>
<td>40</td>
<td>30</td>
<td>5</td>
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<td></td>
<td></td>
<td>CAR TIA</td>
<td>IV heparin</td>
</tr>
<tr>
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<td>59</td>
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<td>Cl</td>
<td>IV heparin</td>
</tr>
</tbody>
</table>

Code Stroke average: 65 | 118† | 41 | 4.8 | 30†
Control average: 61 | 95 | 76 | 25 | 42

P: NS NS .05 .03 .06

T₀⁻ₐ indicates the interval between onset of symptoms and arrival at our facility; Tₛ⁻ₐ, the interval between arrival and the activation of Code Stroke; Tₐ⁻ₑ, the interval between the activation of Code Stroke and the time a member of the stroke team arrived at the bedside; Tₑ⁻ₑ, the time between the beginning of the stroke team's evaluation and the institution of what was considered definitive acute treatment; Cbl, cerebellar infarction; HTN, hypertensive; Cl, cerebral infarction; MCA, middle cerebral artery; BI, brain stem infarction; MET CA, metastatic cancer; VB, vertebrobasilar; TIA, transient ischemic attack; CAR, carotid; ICH, intracerebral hemorrhage; IA, intra-arterial; IV, intravenous; NS, not significant.

*Excluding patient HB.

1Excluding patient HB.

rooms with chest pain and require emergent cardiac consultation to diagnose or exclude the presence of a myocardial infarction.

In summary, several different strategies will be necessary to shorten the various intervals between the occurrence of a stroke and the initiation of definitive treatment. The "golden hour" model used in the management of trauma victims seems to be an appropriate goal to pursue. The first interval (T₀⁻ₐ) will have to be shortened through the expansion of public education. Teaching the community (1) how to recognize the signs and symptoms of stroke and (2) that the emergency medical system (EMS) should be accessed rapidly should lead to improvement of this interval. Furthermore, EMS personnel will have to be instructed (1) about the availability of therapeutic strategies that demand rapid application and (2) that these patients need to be brought to medical facilities promptly.

Once the stroke patient arrives at the treatment facility, shortening the second interval (Tₛ⁻ₐ) will require the rapid recognition by emergency personnel of the possibility (not the certainty) of a stroke, and the proper prioritization of the care needed by the patient in the context of the overall activity of the emergency department. This is particularly important in tertiary care centers with busy emergency services, where stroke victims are often displaced down on the priority list by cardiac or trauma patients. This interval depends most on the relationship between the emergency department staff and the individuals who are responsible for the care of stroke victims. It has been our experience that this relationship can be strengthened by educating emergency department physicians and nurses about the availability of treatment protocols, the availability of specialists willing to quickly assess and treat the patients, and the availability of a rapid-response system that allows specialized care to be delivered quickly.

The Code Stroke system we describe is best suited to shorten the evaluation (Tₑ⁻ₑ) and treatment institution (Tₑ⁻ₑ) intervals. It provides physicians who treat stroke patients with the means to be involved in the care of the patient very early in the course of the condition. This system could have repercussions on the ability to apply specific therapeutic modalities that otherwise would be discarded because of the long latency between onset and availability for treatment. It is also likely to improve the opportunity to enter patients into acute treatment research protocols.
Acknowledgments

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References

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