Background and Purpose—Through 2-way live video and audio communication, telestroke enhances urgent treatment of patients with acute stroke in emergency departments (EDs) without immediate access to on-site specialists. To assess for opportunities to shorten the door to thrombolysis time, we measured multiple time intervals in a telestroke system.

Methods—We retrospectively analyzed 115 records of consecutive acute stroke patients treated with intravenous thrombolysis during a 20-month period via a statewide telestroke system in 17 EDs in Georgia. On the basis of times documented in the telestroke system, we calculated the time elapsed between the following events: ED arrival, telestroke patient registration, start of specialist consultation, head computed tomography, thrombolysis recommendation, and thrombolysis initiation.

Results—The most conspicuous delay was from ED arrival to telestroke patient registration (median, 39 minutes; interquartile range, 21–56). Median time from ED arrival to thrombolysis initiation was 88 minutes, interquartile range 75 to 105. Thrombolysis was initiated within 60 minutes from ED arrival in 13% of patients.

Conclusions—The greatest opportunity to expedite acute thrombolysis via telestroke is by shortening the time from ED arrival to telestroke patient registration.

Key Word: acute stroke | intravenous tissue-type plasminogen activator | ischemic stroke | telemedicine | stroke care | telestroke | thrombolysis

The efficacy of intravenous tissue-type plasminogen activator (tPA) in acute ischemic stroke is greater the earlier it is administered. Consequently, to facilitate the earliest possible tPA treatment of patients with acute stroke, the American Stroke Association recommends specific time thresholds for various intervals of patient evaluation and tPA administration. Multiple strategies can shorten the time to intravenous thrombolysis during acute stroke.

Telestroke is growing in popularity and is being used to facilitate the evaluation and tPA treatment of patients with acute stroke in emergency departments (EDs) without sufficient on-site specialists. Telestroke enables a live 2-way video and audio interaction with the patient for a neurological examination, and it allows the specialist to view neuroimaging scans. In general, the multiple active telestroke systems offer a reliable method for patient assessment, including neurological examination and review of neuroimages, and are recommended for use when an on-site specialist is not immediately available.

There is paucity of data on the timeliness of telestroke in thrombolysis for acute stroke. Here, we tabulate various time intervals from ED arrival to tPA bolus infusion in a statewide telestroke system throughout the state of Georgia, in an effort to identify opportunities to shorten the ED arrival to thrombolysis time. Issues related to delayed ED arrival are also important in acute stroke care but are not investigated here.

Patients and Methods

We retrospectively reviewed consultation records saved in the telestroke system Remote Evaluation of Acute Ischemic Stroke Health Inc., in Georgia. This system includes 17 remote EDs throughout the state with a hub at the Georgia Regents Medical Center, staffed by the Medical College of Georgia physician stroke specialists 24/7. We reviewed all records between March 2011 and November 2012 and identified those using intravenous tPA for acute stroke.

In this telestroke system, after the ED staff logs into the system website and enters the patient name, time of ED arrival, age, sex, vital signs, and time of symptom onset, the patient registration time is recorded automatically. Diagnostic tests are not prerequisite for patient registration in this system. The ED staff then calls the hub Emergency Communication Center at Georgia Regents Medical Center via telephone to request a consultation, and the stroke specialist on call is paged. Additional times that are recorded automatically in this system are the start of head computed tomography (CT), the specialist logging into the system to start the consult, and the specialist clicking a button to recommend tPA. The start of the tPA bolus is recorded by clicking an on-screen button, either by the ED staff or by the specialist. The specialist types a clinical note for each consult that is saved into the system and can be viewed at any time by a registered user.
One medical student (K.M.L.) supervised by 1 of the specialists (A.B.) reviewed the telestroke records for each patient and calculated and tabulated 6 time intervals: (1) from ED arrival to telestroke registration, (2) from telestroke registration to start of consult, (3) from ED arrival to CT, (4) from start of consult to tPA recommendation, (5) from tPA recommendation to bolus, and (6) the total time from ED arrival to tPA bolus. The time of specialist consultation request by the Emergency Communication Center was not documented in this system. The analysis and reporting of the deidentified saved telestroke data have been approved by the Georgia Regents University institutional review board.

**Results**

During the 20-month study period, there were 889 telestroke consultations and 115 patients (13%) were treated with tPA. In 12 patients, the ED arrival time was inconsistent with the specialist note and this time was thus excluded from analysis. In 2 patients, the CT was missing. In 24 patients, the tPA bolus time was not documented. The median time from ED arrival to patient registration in the telestroke system was 39 minutes, from ED arrival to CT 18 minutes, from telestroke registration to start of consultation 12 minutes, from start of consultation to tPA recommendation 24 minutes, from tPA recommendation to tPA bolus 12 minutes, and from ED arrival to tPA bolus 88 minutes (Table). CT was done within the American Stroke Association Target: Stroke recommendation 25 minutes, and from ED arrival to tPA bolus 88 versus 87 minutes. Similar to this study, the main delay in South Carolina was from ED arrival to consultation request (median, 33 minutes). Time from ED arrival to system registration was not reported in the South Carolina study.

One limitation in this study is not having enough information to evaluate the potential reasons for prolongations of the various time intervals. Also, the tPA bolus time was not documented by the consultant or the ED staff in 24 patients (21%). Shortening the various time intervals during acute stroke assessment should expedite thrombolysis and increase the proportion of patients with ischemic stroke eligible for and receiving thrombolysis. Currently, the greatest opportunity to increase the proportion of tPA-qualified patients with stroke via the Remote Evaluation of Acute Ischemic Stroke telestroke system, in addition to minimizing the stroke onset to ED arrival time, is by shortening the ED arrival to telestroke registration time. For example, hospital prenotification by Emergency Medical Services should improve stroke recognition in the ED and shorten the time to specialist notification. Implementing processes proven effective in reducing the door to tPA times in telestroke acute stroke settings should also expedite thrombolysis via telestroke.

**Discussion**

The novel information about the various time intervals from ED arrival to tPA bolus in acute stroke care via the Remote Evaluation of Acute Ischemic Stroke Health Inc telestroke system in Georgia could be used to implement approaches to reduce treatment delays and thus improve telestroke care. The ED arrival to telestroke registration median time of 39 minutes seems amenable to greatest shortening. Possible explanations for this delay include the spoke ED gathering data to support stroke diagnosis in uncertain situations and late recognition of stroke in some patients. This delay was potentially the main reason for the relatively low percentage (13%) of patients treated with tPA within 60 minutes of ED arrival. The median time from ED arrival to specialist notification was not documented but must have been somewhat >39 minutes. The American Stroke Association Target: Stroke recommends ≤15 minutes from ED arrival to specialist notification.

Our findings are similar to those using the same telestroke system in South Carolina. The median times in Georgia versus South Carolina from the start of consult to tPA recommendation were 24 versus 25 minutes, from tPA recommendation to bolus 12 versus 14 minutes, and from ED arrival to tPA bolus 88 versus 87 minutes. Similar to this study, the main delay in South Carolina was from ED arrival to consultation request (median, 33 minutes). Time from ED arrival to system registration was not reported in the South Carolina study.

**Table. Time Intervals from ED Arrival to Intravenous tPA Bolus in 115 Patients Treated Consecutively Via Telestroke**

<table>
<thead>
<tr>
<th>Time Intervals*</th>
<th>Median, Min (IQR)</th>
<th>Target: Stroke Recommendation, Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED arrival to telestroke registration (n=103)</td>
<td>39 (21–56)</td>
<td>Not stated</td>
</tr>
<tr>
<td>ED arrival to specialist notification</td>
<td>Not captured</td>
<td>≤15</td>
</tr>
<tr>
<td>Telestroke registration to start of consult (n=115)</td>
<td>12 (7–21)</td>
<td>Not stated</td>
</tr>
<tr>
<td>ED arrival to CT (n=101)</td>
<td>18 (8–20)</td>
<td>≤25</td>
</tr>
<tr>
<td>Start of consult to tPA recommendation (n=115)</td>
<td>24 (17–30)</td>
<td>Not stated</td>
</tr>
<tr>
<td>tPA recommendation to bolus (n=91)</td>
<td>12 (8–20)</td>
<td>Not stated</td>
</tr>
<tr>
<td>ED arrival to tPA bolus (n=83)</td>
<td>88 (75–105)</td>
<td>≤60 in ≥50% of patients</td>
</tr>
</tbody>
</table>

*CT, computed tomography; ED, emergency department; IQR, interquartile range; and tPA, tissue-type plasminogen activator.

*Some of the times were missing or could not be confirmed.

**References**


Timeliness of Intravenous Thrombolysis via Telestroke in Georgia
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