Does Helicopter Emergency Medical Service Transfer Offer Benefit to Patients With Stroke?

Michael D. Olson, MPAS, PA-C; Alejandro A. Rabinstein, MD

Background and Purpose—Helicopter transportation of patients with acute stroke who have received recombinant tissue-type plasminogen activator is commonly considered the best option. We evaluated if transportation by helicopter can reduce complications and improve clinical outcomes in patients with acute stroke.

Methods—We conducted a review of consecutive patients with acute ischemic stroke transferred to our hospital after intravenous thrombolysis initiated at a referral center.

Results—A total of 122 patient transportations were analyzed, 94 by air and 28 by ground. Time from activation of the transport system to arrival at our hospital was significantly shorter with air transportation (53 versus 68 minutes, \( P=0.04 \)). Two complications were noted in the air group and no complications were noted in the ground group (\( P=1.0 \)). All other outcome measures were not significantly different between groups.

Conclusions—Air transfer of patients with acute ischemic stroke treated with thrombolysis does not seem to impart any benefit to patient outcomes when compared with ground transport. Therefore, ground transport should be considered for these patients unless they are being considered for emergency endovascular rescue therapy. (Stroke. 2012;43:00-00.)

Key Words: acute stroke ■ emergency medical services ■ stroke care ■ thrombolysis ■ tPA

Patients with acute ischemic stroke are often first evaluated and treated at the nearest emergency department and then transferred to a stroke center for admission. When intravenous thrombolysis is initiated at the first point of care (the spoke), the infusion of recombinant tissue-type plasminogen activator (rtPA) can be continued during transportation to the receiving stroke center (the hub). \(^1\) Air transportation by helicopter has become the preferred modality for these patients because of a presumed benefit in reduced out-of-hospital time. \(^2\) This practice mirrors the experience with acute myocardial infarction and major trauma. \(^3\)

Still, given the increased complexity, higher costs, and potential risks of air transfers, \(^4\) it is important to ascertain the differences between air transportation and ground transportation in acute stroke. Small studies offer some evidence that helicopter transfers after or during thrombolysis are safe. \(^5\) However, to our knowledge, no studies have investigated the relative risks and benefits of air versus ground transportation in patients with acute stroke using clinical outcome measures as main end points.

We examined our experience in a comprehensive stroke center to evaluate the safety and value of air transportation as compared with ground transportation after intravenous thrombolysis.

Methods

After approval by our Institutional Review Board, we identified consecutive patients with acute ischemic stroke treated with intravenous rtPA at outside hospitals (spokes) and transported to Saint Marys Hospital in Rochester, MN (hub) by air ambulance or ground ambulance from November 2002 to November 2010 by using Mayo Medical Transport’s centralized, electronic, prehospital chart database. Post-transport data were then abstracted from the electronic medical records. Variables extracted from the emergency medical services chart and the medical records are listed in the online-only Supplement (http://stroke.ahajournals.org), which also includes information on our stroke system. Most hospitals classified as spokes are primary and secondary rural critical access centers located within a 120-mile radius of our hub. Analysis of the data was performed using Wilcoxon, Kruskal-Wallis, and 2-tailed Fisher exact tests.

Results

There were a total of 122 patients with stroke analyzed for the study; 94 patients were transported by air and 28 by ground. All patients in the study had the intravenous rtPA bolus started at the outside hospital. A majority of the patients from both groups had the rtPA infusion given during transportation. Main prehospital and inpatient data are shown in the Table.

Distance in miles from the outside hospital to our hospital was 61 miles for the air group and 59 miles for the ground...
group ($P=0.51$). Time from emergency medical service activation to arrival at the outside hospital was significantly longer in the air group (31 minutes versus 14 minutes in the ground group; $P>0.001$). Transportation time from the outside hospital to our hospital was 24 minutes for the air group and 55 minutes for the ground group ($P>0.001$). Overall time from system activation to arrival at our hospital was 54 minutes in the air group and 69 minutes in the ground group ($P=0.04$). Of the 28 patients transported by ground, 26 of these patients (93%) were transported by ground after air transport was requested and was determined to be unavailable. Prehospital and hospital outcome variables are summarized in the Table. There were 2 complications noted in the air group. One patient had a generalized seizure en route and 1 patient became less responsive with a Glasgow Coma Scale change of 1 point. Interventions (medication administration in all cases) were given en route for 10 patients in the air group and 1 in the ground group. No patients required intubation or advanced airway intervention en route. No patients had significant vital sign changes (defined as changes that required an intervention) en route either. There were no significant differences among any of the hospital outcome variables between the groups. In addition to the data outlined in the Table, there were no patients who required neurosurgical intervention within 12 hours of arrival.

**Discussion**

Although there are many studies looking into the benefits, or lack thereof, of air transportation for patients with acute trauma or myocardial infarction, very few studies have analyzed the benefit of air medical transport in acute ischemic stroke. To our knowledge, our study is the first to investigate clinical outcome measures to determine the value of the modality used for interhospital transportation in patients with acute stroke. As described in the Table, all the prehospital and hospital outcome variables assessed were similar in our air and ground transportation groups. Although our study confirms the safety of air transportation for patients with stroke after intravenous rtPA administration, it demonstrated no difference in the rates of complications or interventions en route to the hospital. In fact, although acknowledging the relatively small sample size of the ground group, no complications were noted en route for patients transported by ground. The 2 complications noted in the air group were relatively minor, readily controlled, and they were not associated with any subsequent problems after arrival to our hospital.

Given its higher cost and complexity, air transfer should result in tangible improvement in objective patient outcomes to be considered the preferred mode of transportation. The lack of complications and interventions en route, the lack of significant differences in Glasgow Coma Scale on arrival, and the similar number of head CT scans within 2 hours, complications within 6 hours, and deaths within 24 hours support the safety of ground transportation in our cohort. More importantly, we found no differences between the 2 groups in any of the clinical end points. The value of transporting patients with acute ischemic stroke who have received rtPA at an outside hospital should be critically re-examined. One of the possible pitfalls of reducing air transportation of patients with stroke is the delay that these patients may have in receiving endovascular therapy such as clot retrieval or intraarterial rtPA, yet only 7 (6%) of the 122 patients included in this study were taken to the interventional suite for additional treatment. In addition, there was only a 15-minute average time difference between activation of the emergency medical services system and arrival to our hospital between the 2 transportation groups. This minimal time difference, albeit statistically significant, does not seem to be sufficient to justify the higher cost of transporting these patients by helicopter. In fact, our findings suggest that air transportation of patients with acute ischemic stroke after intravenous rtPA administration is not generally warranted in our referral area.

Our study is limited by a number of factors. First, although this study is the largest of its kind to date, its sample size is still small, particularly in the ground transportation cohort. Second, although our referral area, and the terrain encompassed within that area, is similar to many locations throughout the United States, it may not be adaptable to other areas with varying topographical challenges. Third, although the majority of ground patients could not be transported by air because of reasons unrelated to their clinical condition (ie, bad weather or flight volumes), it is impossible to definitively rule out referral bias as a possible confounder in the analysis.

In our experience, ground transportation is not associated with greater risk of complications or deterioration en route and patients transported by ground do not have worse hospital courses than those transported by helicopter. Therefore, ground transportation should be considered

---

### Table. Prehospital and Hospital Outcome Variables

<table>
<thead>
<tr>
<th></th>
<th>Air (n=94)</th>
<th>Ground (n=28)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean</td>
<td>73.46</td>
<td>71.64</td>
<td>0.32</td>
</tr>
<tr>
<td>GCS at outside hospital, median (IQR)</td>
<td>15 (13–15)</td>
<td>15 (13–15)</td>
<td>0.90</td>
</tr>
<tr>
<td>Intubation en route, n (%)</td>
<td>0</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>Intervention en route, n (%)</td>
<td>10 (10.6)</td>
<td>1 (3.5)</td>
<td>0.45</td>
</tr>
<tr>
<td>Complication en route, n (%)</td>
<td>2 (2.1)</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>GCS at our hospital, median (IQR)</td>
<td>15 (14–15)</td>
<td>15 (14–15)</td>
<td>0.79</td>
</tr>
<tr>
<td>NIHSS at our hospital, median (IQR)</td>
<td>9 (5–13)</td>
<td>10 (5–13)</td>
<td>0.60</td>
</tr>
<tr>
<td>Head CT within 2 hr of arrival, n (%)</td>
<td>20 (21.2)</td>
<td>8 (28.5)</td>
<td>0.45</td>
</tr>
<tr>
<td>Interventional radiology procedure upon arrival, n (%)</td>
<td>5 (5.3)</td>
<td>2 (7.1)</td>
<td>0.66</td>
</tr>
<tr>
<td>Complication within 6 h, n (%)</td>
<td>10 (10.6)</td>
<td>0</td>
<td>0.11</td>
</tr>
<tr>
<td>Death within 24 h, n (%)</td>
<td>3 (3.1)</td>
<td>0</td>
<td>1.00</td>
</tr>
<tr>
<td>ICU to floor transfer within 2 d, n (%)</td>
<td>76 (80.8)</td>
<td>22 (78.5)</td>
<td>0.79</td>
</tr>
<tr>
<td>Intracranial hemorrhage, n (%)</td>
<td>13 (13.8)</td>
<td>3 (10.7)</td>
<td>1.00</td>
</tr>
<tr>
<td>Length of hospitalization, mean</td>
<td>6.75</td>
<td>7.21</td>
<td>0.66</td>
</tr>
<tr>
<td>30-d mortality, n (%)</td>
<td>16 (17)</td>
<td>7 (25)</td>
<td>0.49</td>
</tr>
<tr>
<td>Modified Rankin Scale score at discharge, median (IQR)</td>
<td>3 (1–4)</td>
<td>3 (1–5)</td>
<td>0.72</td>
</tr>
</tbody>
</table>

GCS indicates Glasgow Coma Scale; NIHSS, National Institutes of Health Stroke Scale; ICU, intensive care unit; IQR, interquartile range.
reasonable for patients with acute stroke receiving intravenous rtPA unless endovascular rescue therapy is likely to be pursued.

Disclosures
None.

References
Does Helicopter Emergency Medical Service Transfer Offer Benefit to Patients With Stroke?
Michael D. Olson and Alejandro A. Rabinstein

Stroke. published online December 8, 2011;
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2011 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/early/2011/12/08/STROKEAHA.111.640987

Data Supplement (unedited) at:
http://stroke.ahajournals.org/content/suppl/2011/12/08/STROKEAHA.111.640987.DC1

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org//subscriptions/
### Pre-hospitalization data
- Location of the outside hospital
- Time of initiation of EMS services
- Date of transportation
- Distance from our hospital
- Time of ambulance request
- Time of arrival at the outside hospital
- Time en route back to our hospital
- Time of arrival at our hospital
- Age
- Sex
- GCS score at the outside hospital
- Intubation at the outside hospital or en route to our hospital
- Interventions en route (i.e. drug administration [not including rtPA] and procedures)
- Complications en route (i.e. vital sign changes, neurological worsening, systemic complications)

### Hospitalization data
- GCS upon arrival to our hospital
- NIHSS score upon arrival to our hospital
- Any brain imaging obtained within 2 hours of arrival for neurological decline
- Any neurosurgical intervention within 12 hours of arrival
- Any interventional radiology intervention within 24 hours of arrival
- Complications within 6 hours as defined by any worsening in patient status noted in the medical record
- Intracranial hemorrhage during hospitalization
- Time of transfer from ICU to the floor
- Death within 24 hours
- Final diagnosis
- Length of hospital stay
- Modified Rankin Score at discharge
- Disposition at discharge (home, nursing home, inpatient rehabilitation, assisted living, or death)
- Death within 30 days

EMS, emergency medical transportation; GCS, Glasgow coma score; NIHSS, National Institutes of Health Stroke Scale.
Regional Acute Stroke Program: systems of care

In our systems, there are multiple spokes (26) and one hub (Saint Marys Hospital, Rochester, MN). In our air transport system, there are three helicopters, one based at the hub and two others based strategically in the outlying community closer to the spokes. In regards to ground transport, each of the hospitals has a ground ambulance service in the town they are based. For several of the larger spoke hospitals, these ground ambulance service is owned and operated by Mayo Clinic Medical Transport, which shares a centralized dispatch and similar protocols with the air system.