Cutting the Prehospital On-Scene Time of Stroke Thrombolysis in Helsinki
A Prospective Interventional Study

Tuukka Puolakka, MD; Markku Kuisma, MD, PhD, EMDM; Sami Länkimäki, MD; Jyrki Puolakka, MD; Juhana Hallikainen, MD; Kirs Hantaan, MD; Perttu J. Lindsberg, MD, PhD, FESO

Brief Report

Background and Purpose—Significant portion of the prehospital delay consists of minutes spent on the scene with the patient. We implemented a training program for the emergency medical services personnel with the aim to optimize the on-scene time (OST) and to study the impact of different elements of prehospital practice to the OST duration.

Methods—In this prospective interventional study, key operational emergency medical service performance variables were analyzed from all thrombolysis candidates transported to the Helsinki University Hospital emergency department. The catchment period was 4 months before and 4 months after the implementation.

Results—One hundred and forty-one patients were managed as thrombolysis candidates before and 148 patients after the training program implementation. The OST duration for the groups was 25 (20.5–31) and 22.5 (18–28.5) minutes, respectively (P<0.001). Physician consultations via telephone were associated with a longer (odds ratio 0.546 [0.333–0.893]) and advanced life support training with a shorter OST (odds ration 1.760 [1.070–2.895]).

Conclusions—Implementation of the emergency medical services training program successfully decreased the OST of thrombolysis candidates by 10%. Higher expertise level of the ambulance crew was associated with shorter OST, and decisions to consult a physician via telephone were reflected by longer OST. (Stroke. 2016;47:00-00. DOI: 10.1161/STROKEAHA.116.014531.)

Key Words: ambulance ■ attention ■ emergency medical services ■ expedition ■ stroke

Significant progress has been made in Helsinki stroke chain of survival in streamlining the in-hospital management of stroke thrombolysis patients, but similar expedition has proved difficult to achieve in the prehospital management steps.1 In selected comprehensive stroke centers, the door-to-treatment time for intravenous thrombolysis is already well <30 minutes, but the prehospital onset-to-door time has remained stagnant above the 60-minute mark through almost 2 decades.2–4 Although patient-dependent deliberations still dominate the prehospital bottleneck, problems do exist within the organized chain of recovery.5–6 Although early symptom recognition, ambulance dispatch using the stroke code, and transport using high priority have received considerable attention in numerous reports, similar honing has not occurred in the workflow of the ambulance crew operating on the scene.

In our first 3-year report of the sequential prehospital delays of thrombolyzed patients, the on-scene time (OST) varied between 18 and 23 minutes depending on symptom severity.2 To our surprise, our recent analysis revealed that the median OST had increased to 24 minutes—almost 10 minutes longer than the current American Stroke Association guidelines recommend (≤15 minutes).2 This led us to perform a quality assurance program, including a lecture-based training package for the emergency medical system (EMS) personnel, aiming to shorten the on-scene operation and streamline the workflow. This study aimed to decrease the median OST of thrombolysis candidates to ≤20 minutes by enhancing the performance of the personnel with a focused training program.

Methods

The planning of this prospective interventional study took advantage of existing continuously gathered prehospital EMS data. The study plan was approved by the Departments of Emergency Medicine and Neurology of the Helsinki University Hospital. Because the study

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The online-only Data Supplement is available with this article at http://stroke.ahajournals.org/lookup/suppl/doi:10.1161/STROKEAHA.116.014531/-/DC1.
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was register based, no separate ethical review board approval was required. The study setting, existing prehospital stroke protocol, hospital emergency department (ED) process, and data collection principles have been described elsewhere.5,6 During a 3-month training period, all ambulance crews (both advanced and basic life support certified) in the Helsinki University Hospital area attended a 45-minute training session and participated in interactive follow-up group sessions (online-only Data Supplement).

The key practice points targeted by the training program were to (1) increase general time awareness of the EMS staff (ie, adding an OST timer function to the paramedics’ laptop computers), (2) limit the overall number of emergency on-scene procedures (ie, ≤3 allowed attempts in intravenous cannulation), (3) transport the patient to the ambulance using a carrying chair instead of an ill-maneuverable stretcher, and (4) transform the general management workflow into a typical load and go setup to automate fast assessment and immediate transport.

All patients transported by ambulances to Helsinki University Hospital ED using the stroke code 4 months before and after the training period were registered, and their prehospital electronic patient reports were retrieved from the Merlot Medci (CGI Inc) database. Transportations from other healthcare institutions were not included.

Key operational variables describing EMS performance were compared before and after implementing the training program. A dichotomized analysis was made to short and long OST duration groups using the sample median. Variables with >90% complete data sets and P<0.2 were selected for regression analysis to determine associations with a short OST. The statistical analysis was conducted using the SPSS 21 statistical package. Significance was considered at P<0.05.

Results
During the 8-month study period, the EMS transported a total of 879 suspected stroke patients to Helsinki University Hospital, of which 20 were regarded as interfacility transports. Of the remaining 859 patients, 289 were identified as potential thrombolysis candidates by the emergency medical dispatchers and managed accordingly by the EMS using high priority ambulance transport, the stroke code, and a prenotification to the ED. One hundred and forty-one patients were registered before and 148 after the implementation of the training package. The groups did not differ in terms of patient age, sex, frequency of physician’s telephone consultations, or number of advanced life support–trained crews (P>0.1), but the training program was found to be followed by a decrease in the OST by 10% (Figure). However, this did not translate into net savings in the overall dispatch-to-hospital time, which remained at 45 minutes (P>0.1).

Consultation with a prehospital emergency physician or a neurologist via telephone was associated with longer on-scene durations in the univariate comparisons and multivariable regression model, whereas higher training level of the EMS personnel promoted a shorter OST. Participation in the training program showed a strong trend toward shorter OST durations (Tables 1–2).

Discussion
This study describes novel steps in the continuous optimizing and honing of the stroke chain of recovery in the comprehensive stroke center in Helsinki.2,3,5,6 Although several components of the prehospital chain of thrombolysis candidates are

### Table 1. Comparison of Thrombolysis Candidates With Short and Long Scene Times

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>OST ≤24 min (n=142)</th>
<th>OST &gt;24 min (n=146)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>284</td>
<td>64 (16)</td>
<td>68 (17)</td>
<td>0.079</td>
</tr>
<tr>
<td>Male sex</td>
<td>284</td>
<td>51.4</td>
<td>47.2</td>
<td>0.553</td>
</tr>
<tr>
<td>ALS-trained ambulance crew</td>
<td>288</td>
<td>64.1</td>
<td>53.4</td>
<td>0.073</td>
</tr>
<tr>
<td>Physician consulted</td>
<td>288</td>
<td>42.3</td>
<td>54.8</td>
<td>0.035</td>
</tr>
<tr>
<td>Stroke training package received</td>
<td>288</td>
<td>57.0</td>
<td>45.9</td>
<td>0.061</td>
</tr>
<tr>
<td>Dispatch-to-scene time</td>
<td>282</td>
<td>7.5 (5.5–9.0)</td>
<td>7.0 (5.5–9.0)</td>
<td>0.757</td>
</tr>
<tr>
<td>Dispatch-to-patient time</td>
<td>254</td>
<td>9.5 (7.5–11.5)</td>
<td>9.5 (7.5–11.5)</td>
<td>0.506</td>
</tr>
<tr>
<td>Ambulance transport time</td>
<td>238</td>
<td>13.5 (10.0–17.5)</td>
<td>11.0 (7.0–15.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Dispatch-to-hospital arrival</td>
<td>237</td>
<td>41.0 (35.0–45.5)</td>
<td>50.5 (43.5–56.0)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Variables presented using mean (SD), percentage, or median (interquartile range). Age measured in years and time intervals in minutes. ALS indicates advanced life support; and OST, on-scene time.
dictated by the surroundings (ie, rush hour traffic), the workflow of the on-scene management is modifiable and includes adjustable performance task variables. This report highlights the possibility to decrease the OST significantly with a dedicated training program targeting the existing, experienced EMS personnel. This study also demonstrates that the training of ambulance crews and their decisions about physician consultations influence the composition of the OST and the prehospital phase. Fewer consultations and less time on-scene did not lead to premature rushing of patients into ED, because 10% more patients reached the hospital diagnosis of cerebral ischemia (P<0.1) to receive recanalization therapy with at least the same frequency (intravenous thrombolysis alone 14.3% and thrombolysis+thrombectomy 5.4%; online-only Data Supplement).

Earlier reports from the United States and Denmark have described shorter OSTs of between 15 and 18 minutes.7,8 However, these reports lacked valuable information about the convergence of prehospital and in-hospital phases to expedite in-hospital management. Because different EMS systems can have fundamental differences, direct comparisons are difficult, and the ideal OST must be determined locally. The key is to do as little as possible on the scene but not to omit tasks that delay the ED process (ie, intravenous cannulation). Because emergency procedures in a moving vehicle can jeopardize both the patient and the EMS personnel, they should be avoided. However, postponing the hospital prenotification and some written reporting and the EMS personnel, they should be avoided. However, postponing the hospital prenotification and some written reporting

In conclusion, the EMS training package successfully decreased the OST of thrombolysis candidates by 10%, from 25 to 22.5 minutes. Higher advanced life support training of the ambulance crew was associated with a shorter OST and the decision to consult a physician via telephone with a longer OST. Despite the fact that the prehospital chain of care is largely dependent on the incidental physical setting, several minutes can still be spared by a focused training program targeting on how to operate on the scene of an acute stroke.

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Disclosures

None.

References


Table 2. Variables Independently Associated With On-Scene Time Duration in Binary Logistic Regression Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>p Value</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Older age, y</td>
<td>0.065</td>
<td>1.014 (0.999–1.029)</td>
</tr>
<tr>
<td>Ambulance crew not ALS trained</td>
<td>0.026</td>
<td>1.760 (1.070–2.895)</td>
</tr>
<tr>
<td>Physician not consulted</td>
<td>0.016</td>
<td>0.546 (0.333–0.893)</td>
</tr>
<tr>
<td>Stroke training package not received</td>
<td>0.074</td>
<td>1.550 (0.959–2.505)</td>
</tr>
</tbody>
</table>

ALS indicates advanced life support; CI, confidence interval; OR, odds ratio.
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Data Supplement (unedited) at:
http://stroke.ahajournals.org/content/suppl/2016/11/15/STROKEAHA.116.014531.DC1.html
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– A Prospective Interventional Study

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Supplemental Methods

Study setting

Helsinki University Hospital (HUH) is the largest comprehensive stroke center in Finland and manages all neurologic emergencies in the Helsinki metropolitan area and surrounding region. Its catchment area covers approximately 1.5 million inhabitants and the 65-bed ED has 30,000 visits a year, of which approximately 1,100 are stroke patients.

The Helsinki region has a three-tiered emergency medical service (EMS) system consisting of two-manned basic life support and advanced life support ambulances and two physician-staffed mobile intensive care units. The EMS uses an electronic patient reporting system that stores all prehospital patient report and operative data in a common database. Finland has a general emergency number “112” and all the emergency phone calls in the Helsinki area are managed by the regional emergency medical communications center. Acute stroke is screened using the Face Arm Speech Time (FAST) –algorithm. In suspected acute stroke, the nearest ambulance unit is dispatched using the stroke code and high priority (“lights and sirens”).

On the scene, the ambulance crew interviews the patient and possible bystanders and conducts a quick neurological examination based on the FAST-algorithm. Glasgow Coma Scale score, blood pressure, oxygen saturation, tympanic temperature, and blood glucose are measured. An intravenous line is set for fluid therapy, enabling also later contrast agent administration. If the patient's symptoms clearly fit acute stroke and started less than five hours earlier, a prenotification phone call is placed to the ED staff on prompt high-priority transport. Atypical symptoms can be discussed on the telephone with an EMS physician or directly with hospital stroke neurologist.

Training package design

The aim of the training package was to implement that ambulance transport of a “stroke thrombolysis candidate” would begin within the target interval of 20 minutes after arriving beside the patient. The EMS operation on the scene in acute stroke should therefore resemble the prehospital management strategy in penetrating chest trauma (“load-and-go”).

The training package was designed as a joint project by the medical directors for EMS (M.K, S.L, J.P. and J.H.) in the Helsinki University Hospital region and the senior paramedics and emergency medical technician (EMT) -trained firemen at the Helsinki City Rescue Department. The medical directors and the HUH emergency department neurologist (K.R.) set the goals for the training content and materials. The EMS staff at the Helsinki City Rescue Department were asked to provide their opinions and practical suggestions on how these goals would be best achieved.

The structural design process involved twelve separate 20-minute brainstorming sessions where altogether 149 EMT firemen provided their development ideas from the grass-root level of prehospital practice. The results were assimilated into a lecture-based training package.

Implementation

A 45-minute lecture with slides and a following group discussion was arranged as a part of the routine EMS training that covers essential medical themes in a rotating manner. The training covered all operative EMS personnel in the HUH area which includes three city-based fire-rescue departments and one private EMS contractor. Roughly 85% of the personnel participated in the training during a three-month period in 1.6.–31.8.2015. Absence from the training session was mainly due to it being the summer holiday season. Additionally, an on-screen timer showing the time spent on the scene was added to the electronic patient-reporting system (Merlot Medi, CGI Inc. Canada) used by the EMS to improve time awareness on the scene.
Ideas from the EMS staff were welcomed throughout the project. Cases with very long on-scene times were reviewed by the EMS directors and feedback was given to the staff.

The EMS performance was measured on a 4-month period before (1.2-31.5.2015) and after (1.9-31.12.2015) the training period.

**Training package contents**

1. After the patient has been identified as a candidate for intravenous thrombolysis, prehospital operation should be prompt but concise.
2. Communication is crucial. If anyone thinks the patient might have a stroke, it should be said aloud.
3. Emergency medical technicians or paramedic students should not be allowed to examine the patient or train procedures if the patient meets the criteria for a thrombolysis candidate.
4. Instead of a stretcher, a carrying-chair can be used to effectively move the patient to the ambulance. The chair should be taken from the ambulance already when meeting the patient for the first time.
5. Intravenous cannulation is attempted three times at most on the scene. Unsuccessful cannulation should be mentioned in the hospital prenotification.
6. A 12-lead ECG should not be taken without obvious cardiac symptoms – heart rhythm monitoring is enough in most cases.
7. Make sure that the phone number of the patient’s relatives or bystanders is written on the prehospital patient report. The neurologist may need this to acquire additional information or to discuss treatment decisions.
8. Time should not be used on the scene to gather the patient’s clothes or other personal items. The patient’s family members can later bring all the necessary items to the hospital.
9. A prenotification to HUH emergency department should be given immediately after ambulance transport has begun. If the transport time is estimated to be very short (<10 minutes), consider giving the prenotification on the scene before transport in order to enable necessary preparations at the ED.
10. A good prenotification is short and concise. Medical problems requiring immediate resolution at the ED such as the patient’s deteriorating consciousness or unsuccessful IV cannulation should be mentioned.
11. If the patient meets the Face Arm Speech Time (FAST) criteria, and the suspicion for acute stroke is high, consulting a physician is not necessary and a straightforward approach is encouraged.
12. Additional EMS units should not be requested to the scene without obvious need (i.e. advanced emergency procedures, morbid obesity).

**Safety on the scene and during transport**

Striving toward target duration in the on-scene operation should be done professionally and swiftly. Safety of the patients or EMS personnel should not jeopardized. Intravenous cannulation should not be attempted in a moving vehicle as the risk of needle stick injuries in these circumstances is high. The quality of patient examination and adequate documentation should not be compromised. Safety belts should be used at all times during ambulance transport, and the ambulance should pull over if the patient’s condition requires management en-route to the hospital.
Supplemental tables

Table I. Comparison of patients registered before and after the training package implementation.

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Before (n=141)</th>
<th>After (n=148)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>285</td>
<td>65 (17)</td>
<td>66 (16)</td>
<td>0.561</td>
</tr>
<tr>
<td>Male</td>
<td>289</td>
<td>47.5</td>
<td>50.7</td>
<td>0.636</td>
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<tr>
<td>ALS-trained ambulance crew</td>
<td>289</td>
<td>57.4</td>
<td>59.5</td>
<td>0.811</td>
</tr>
<tr>
<td>Dispatch-to-scene time</td>
<td>282</td>
<td>7.5 (5.5-9.0)</td>
<td>7.0 (5.5-9.0)</td>
<td>0.853</td>
</tr>
<tr>
<td>Dispatch-to-patient time</td>
<td>254</td>
<td>9.5 (7.5-11.5)</td>
<td>9.5 (7.5-11.5)</td>
<td>0.723</td>
</tr>
<tr>
<td>On-scene time</td>
<td>288</td>
<td>25.0 (20.5-31.0)</td>
<td>22.5 (18.0-28.5)</td>
<td>0.003</td>
</tr>
<tr>
<td>Ambulance transport time</td>
<td>238</td>
<td>12.0 (7.5-16.0)</td>
<td>12.0 (9.0-17.0)</td>
<td>0.417</td>
</tr>
<tr>
<td>Dispatch to hospital arrival</td>
<td>237</td>
<td>45.0 (41.5-54.0)</td>
<td>44.5 (38.0-52.0)</td>
<td>0.152</td>
</tr>
<tr>
<td>Physician consulted</td>
<td>289</td>
<td>51.8</td>
<td>45.3</td>
<td>0.291</td>
</tr>
<tr>
<td>Hospital diagnosis ischemic stroke or TIA</td>
<td>283</td>
<td>51.4</td>
<td>61.4</td>
<td>0.099</td>
</tr>
<tr>
<td>Recanalization therapy given</td>
<td>287</td>
<td>20.0</td>
<td>21.1</td>
<td>0.886</td>
</tr>
<tr>
<td>IVT only</td>
<td></td>
<td>16.4</td>
<td>14.3</td>
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<td>EVT only</td>
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<td>2.1</td>
<td>1.4</td>
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<tr>
<td>IVT + EVT</td>
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<td>1.4</td>
<td>5.4</td>
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</table>

Variables presented using mean (standard deviation), median (interquartile range) or percentage.
Age measured in years and time intervals in minutes. ALS= advanced life support, EVT= endovascular treatment, IVT= intravenous thrombolysis, TIA= transient ischemic attack.