Prehospital Scales for Large Vessel Occlusion

Closing in on a Moving Target

Patrik Michel, MD

See related article, p 290.

The strong evidence for benefits of rapid thrombectomy in patients with acute ischemic stroke (AIS) is challenging prehospital systems around the world. Although high-tech endovascular treatment (EVT) works only for a minority of patients, healthcare systems cannot afford to miss suitable candidates anymore. Recent figures show eligibility of $\approx 25\%$ for thrombolysis and $\approx 10\%$ for EVT in all AIS arriving at the hospital within 24 hours.1 Still, paramedics, local hospitals, and primary stroke centers are struggling to clinically identify the AIS patients who are likely to have intracranial large vessel occlusions (LVO) in the anterior and posterior circulation.

A similar problem was posed 20 years ago when we needed to identify stroke patients requiring immediate transfer to a thrombolyzing institution. Several prehospital schemes proved to be useful, such as the Cincinnati Prehospital Stroke Scale, the Los Angeles Prehospital Stroke Screen, or the Face-Arm-Speech-Time test (FAST). Still, even today, no uniform score with a single cutoff is widely accepted. Many prehospital systems use simple descriptive terms for patient selection that include a maximal delay since last proof of good health, a potentially disabling neurological deficit, absence of a major preexisting handicap, and absence of initial seizures. Whether we use a score or a simple descriptive algorithm, most stroke-admitting hospitals accept a significant rate of overdiagnosis of AIS that are considered potentially thrombolyzable in the prehospital phase. Such overdiagnosed patients may have rapidly improving and minor strokes, stroke mimics, or intracranial hemorrhages.

As for the new challenge of identifying patients eligible for EVT, that is, patients having an acute LVO and coming rapidly to the attention of the emergency medical system, there is a seemingly simple solution: get the patient to a computed tomography/computed tomographic angiography or magnetic resonance/magnetic resonance angiography as fast as possible, if needed, even in a mobile imaging facility.2 This rapid and widespread diagnostic option should indeed be a top priority for all acute stroke systems. Yet, geographical and financial challenges are limiting the access to such imaging. If we are adding the limited number of labor-intensive endovascular facilities, the need for effective clinical prehospital criteria to identify EVT-eligible patients will persist for a long time.

Figure shows 3 typical pathways for suspected AIS patients in the 3-level care system that currently exists in many countries3 and was formalized recently by the World Stroke Organization.4 Using this map of acute stroke care, several important considerations come to light:

- **Pathway A**: arrival at a nonthrombolyzing hospital: such patients should immediately be sent to a thrombolyzing hospital (pathway A2 or A3, ship-and-drip), without being offloaded from the ambulance. Most ideally, such nonthrombolyzing hospitals should be bypassed by patients who have the prehospital criteria, and patient should be taken directly to a thrombolyzing hospital (pathway B) or EVT-capable comprehensive stroke center (pathway C).
- **Pathway B**: admission to a thrombolyzing hospital (usually a primary stroke center): Sending patients directly to thrombolyzing hospitals is currently the preferred attitude in 2-level stroke care systems as recommended in Europe.5 Along this pathway, thrombolytic should be initiated immediately after radiological exclusion of intracranial bleeds. Once thrombolysis is running, arterial imaging is rapidly added to identify and transfer suitable endovascular patients (drip-and-ship, pathway B2).
- **Pathway C**: direct admission of clinically selected patients directly comprehensive stroke centers capable of EVT (termed the mother-ship approach) is likely to be quicker and therefore have more benefit for patients with LVOS, although this still needs to be proven.6 Also, the in-hospital delays in a streamlined one-stop imaging-to-thrombolysis-to-EVT procedure are likely less than the imaging-to-drip-and-ship approach. But again, pathway C requires important investments in the prehospital organization and EVT-capable centers willing to accept a significant rate of LVO overdiagnosis.

There are several opportunities to use clinical scales in the stroke rescue chain, as denoted by the asterisks in Figure. To identify EVT candidates, such preimaging scores should be able to do the following:

1. Avoid missing EVT-eligible patients, that is, avoid underdiagnosing these patients (also expressed as false-negative rate, ie, 1-sensitivity). We suggest aiming at an underdiagnosis rate of $\leq 10\%$ for most geographic scenarios.
2. Avoid overdiagnosing patients not eligible for EVTs, that is, avoid overloading the endovascular EVT-institution with inadequate patients (also expressed as false-positive rate, ie, 1-specificity). An acceptable rate of overdiagnosis could be 30% to 50% or somewhat less than half of all patients directed to an endovascular center, who would not fulfill treatment criteria after arterial imaging.
Virtual International Stroke Trials Archive (VISTA) group8 ana-
in the prehospital setting as they require extensive training.

Overdiagnosis. However, they are less practical to implement
false-positive at a cutoff of 13 points), do decrease the rate of
in the SITS-IST registry (Safe Implementation of Thrombolysis
lyzes LVO predictors in patients receiving reperfusion therapies
in Stroke International Stroke Thrombolysis). It confirms that
able rate. More complex scores based on the National Institute
of Health Stroke Scale, including the ASTRAL (Acute Stroke
over LVO by 46% to 100%, the latter evidently being an unaccept-
which we already do with the current pre-
hospital selection processes for thrombolysis.

Using the available data, each stroke triage system should
now choose its preferred simple score for the paramedical per-
sonnel and nonstroke physicians.13 In addition, the moment
such a score is used and its cutoffs should be adapted to local
circumstances and resources. Stroke-trained physicians
without access to immediate arterial imaging can increase the
precision of triage by using one of the more complex LVO
scores such as the National Institute of Health Stroke Scale,11
the RACE (Rapid Arterial Occlusion Evaluation),14 or the
ASTRAL-occlusion score12 (listed in Table 1). Nevertheless,
the scores should not distract us from our obligation to imple-
mant rapid arterial imaging as a standard of care in all hospi-
tals accepting stroke and potentially in ambulances.

Where should further research go from here? First, we
need to pursue the work on prehospital LVO scores that fol-
low the challenging criteria listed in Table 2, such as external
validation in prehospital settings of unselected populations
with suspected AIS. Second, the impact of the real-life appli-
cation of such scores has to be analyzed, as recently done by
Mohamad et al.15 They showed, in a retrospective before-and-
after study, that the combined use of 4 items to triage patients
directly to EVT-capable centers reduced treatment delay
and improved outcome. Third, randomized trials of drip-
and-ship versus mother-ship approaches based on a prehos-
pital LVO score should be initiated. And last, we may need
to adjust our research target: rather than aiming at LVO only,
we should develop prehospital scores that identify patients
with LVO who are likely to respond to EVT. Treatment
response may be better in patients with fewer comorbidities,
less metabolic disturbances, and a favorable TRAIT imaging

The current article by the Stroke Imaging Research (STIR)/
Virtual International Stroke Trials Archive (VISTA) group9 ana-
lyzes LVO predictors in patients receiving reperfusion therapies
in the SITS-IST registry (Safe Implementation of Thrombolysis
in Stroke International Stroke Thrombolysis). It confirms that
several simple LVO scores (listed in Table 1) performed reason-
ably well for predicting LVO. A new score developed by the
authors combining FAST with gaze deviation (G-FAST) seems
to perform as well as the entire National Institute of Health
Stroke Scale. Still, allowing for an ≈10% rate of missed LVOs
(false-negative rate of 10%), the authors confirm an important
overdiagnosis rate with all scores. As the authors nicely show,
choosing higher cutoffs in the scores decreases the overtriage
but increases the risk of missing a LVO. It looks like we have
to accept a certain proportion of over- and underdiagnosis with
any prehospital criteria, as we already do with the current pre-
hospital selection processes for thrombolysis.

Table 1. Overview of Several Scores Tested for LVO
Prediction in AIS

<table>
<thead>
<tr>
<th>Simple Scores (Paramedics)</th>
<th>Cutoff</th>
<th>Complex Scores (Stroke Physicians or Nurses)</th>
<th>Cutoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Cincinnati Stroke Triage</td>
<td>≥1</td>
<td>RACE</td>
<td>≥2</td>
</tr>
<tr>
<td>Assessment Tool (C-STAT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los Angeles Motor Scale</td>
<td>≥4</td>
<td>Full NIHSS</td>
<td>≥7*</td>
</tr>
<tr>
<td>(LAMS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prehospital Acute Stroke</td>
<td>≥2</td>
<td>ASTRAL-occlusion score</td>
<td>≥13</td>
</tr>
<tr>
<td>Severity (PASS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaze-Face-Arm-Speech-Time</td>
<td>≥3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(G-FAST)</td>
<td></td>
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</table>

The cutoffs to achieve a false-negative rate are ≈10% according to current
criteria.6–12 At these cutoffs, there is always a significant false-positive rate
(overdiagnosis) of LVO. Most scores still need prehospital validation. AIS
indicates acute ischemic stroke; ASTRAL, Acute Stroke Registry and Analysis
of Lausanne; LVO, large vessel occlusion; NIHSS, National Institute of Health
Stroke Scale; and RACE, Rapid Arterial Occlusion Evaluation.

*NIHSS cutoff for a low false-negative rate may be lower in certain studies
and at later time windows.
profile (Treatment-Related Acute Imaging Target). The latter includes good collaterals, small ischemic core, and important mismatch, factors that may be predicted on clinical grounds in the prehospital phase. The treatment response of favorable TRAIT profile patients is likely to be time independent. Therefore, future research should aim at prehospital scores identifying LVO patients ≤24 hours with moderate to high likelihood of EVT response, rather than limiting our search to identifying just LVO in short time windows, such as 0 to 6 hours.

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Disclosures
None.

References
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