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PREHOSPITAL STROKE ASSESSMENT FOR LARGE VESSEL OCCLUSIONS: A SYSTEMATIC REVIEW

William Krebs, DO, Travis P. Sharkey-Toppen, MD, PhD, Fern Cheek, AMLS, Eric Cortez, MD, Ashley Larrimore, MD, David Keseg, MD, Ashish R. Panchal, MD, PhD

ABSTRACT

Background and Objective: Stroke is the leading cause of disability in the United States and new evidence shows interventional procedures provide better outcomes for large vessel occlusions (LVO). We performed a systematic review of the literature on prehospital stroke scales used to identify LVOs comparing the scales with analysis of the sensitivity, specificity, and predictive values. The goal was to determine if emergency medical services (EMS) are able to accurately identify LVO in the field. Methods: In this systematic review, multiple databases were searched for articles that addressed our goal. The identified studies were evaluated for their statistical performance of various stroke scales. In addition, we assessed biases that may explain the varying results reported. Results: Eight studies encompassing 6787 patients were included in our systematic review. Of the 8 studies, 6 were retrospective studies, 1 was a prospective cohort, and 1 was a prospective observational study. Sensitivities of the studies ranged from 49% to 91% while specificity of the studies varied from 40% to 94%. Conclusion: At this time, further evaluations must be done in the prehospital setting to determine the ease of use and true sensitivity and specificity of these scales in identifying LVOs. Key words: stroke; acute; stroke score; review; systematic

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INTRODUCTION

Stroke is the fifth leading cause of death in the United States and the number one cause of disability affecting approximately 795,000 people per year (1). Current therapies are directed at the need for early and rapid interventions to preserve neurological function including thrombolysis and thrombectomy (2). Recent studies have shown that stroke patients with large vessel occlusions (LVO) treated with targeted endovascular thrombectomy demonstrate a two-fold improvement in modified Rankin Score post stroke (3–7). Similar benefit from endovascular intervention for LVO has been demonstrated in real world settings external to randomized control trials (8). These results are suggestive that improved access to interventional stroke care may yield improved overall patient outcomes. Currently, the American Heart Association has developed a Severity-based Stroke Triage Algorithm for EMS that highlights the need for LVO identification followed by transports of patients to facilities where intervention may be performed (9).

Currently, endovascular interventions are only available at facilities with trained interventional teams (10). These are often in highly populated urban centers surrounded by small hospitals which may not have interventional capability. As a result, the prehospital recognition of these LVOs could determine the most appropriate hospital destination for patients with suspected LVO. This requires accurate prehospital neurological assessments for the detection of LVO that could identify candidates for endovascular intervention. Studies have demonstrated that modified stroke scales designed for EMS professionals can facilitate identification of stroke and LVO (11–15). However, the most accurate scale to evaluate large vessel occlusions is unclear.

To date there are a number of stroke scales available to assist in the identification of LVOs but it is unclear which of these scales is ideal for the prehospital identification of LVOs. In this evaluation we performed a systematic review of the literature on prehospital stroke scales and their ability to detect LVO. The objective of this evaluation was to identify which prehospital stroke scales can best assist in the identification of LVO in the prehospital setting with particular attention to sensitivity and specificity.

METHODS

Study Design

This evaluation is a systematic review of the evidence concerning prehospital stroke scales to best identify
large vessel occlusion. Our PICO assessment (P: Problem, I: Intervention, C: Comparison, O: Outcome) was focused on (P) the people potentially suffering from a LVO in the prehospital setting, (I) what tools were available in the form of stroke scales to differentiate these patients (C) from those without LVOs, and (O) provide a basis for prehospital identification and patient destination location for suspected LVO.

We included studies assessing stroke scales that were designed and derived to the population of the prehospital provider within the emergency care setting. Only full-text articles published in English were considered. Each article had to report sensitivity and specificity for large vessel occlusion based on the assessed stroke scales and needed to include confirmatory radiographic testing of the presence of the LVO. Studies only reported as abstracts were excluded, as were opinion articles, editorials, and case reports.

Search Strategy
To identify studies eligible for review, one author (FC) performed computerized searches of bibliographic databases. Databases included the following: PUBMED, Biosis Preview, Cochrane, CINAHL, SCOPUS, Embase, clinicaltrials.gov, Web of Science, and the Grey Literature sources, Google Search, and TRIP database. Search was conducted for all databases from the period from origination to search date (March 7, 2017). The keywords searched were emergency medical services diversion stroke OR ambulance diversion stroke OR emergency medical services stroke protocol OR paramedics stroke OR emergency medical services routing stroke OR Time-to-treatment [MESH] AND stroke [MESH] to identify relevant studies. No limits (language, years) were applied to these searches. For more detail of the search conducted with terms see appendix/supplement. In addition, articles were added at the discretion of the authors based on independent hand search of the bibliography of all included studies to identify any potentially relevant studies not captured in our initial search. An individual search confirmed that the papers identified by hand search were the only papers missed in the initial automated search. Two authors (TS, WK) screened each abstract for inclusion and exclusion criteria. The complete text of this subset was then assessed by two authors (TS, WK) to ensure all inclusion and exclusion criteria were satisfied.

Data Extraction and Assessment
Population size, sensitivity, specificity and prevalence, as well as negative predictive values (NPV) and positive predictive values (PPV) if available were extracted by two authors (TS, WK) and evaluated by the full committee of authors. If negative or positive predictive values were not reported in the original publications these values were calculated as indicated.

Risk of Bias
A risk of bias assessment was performed by two authors (TS, WK) following the methodology described in Cochrane Handbook for Systematic Reviews of Interventions (16). Specifically, we conducted a domain-based evaluation utilizing the The Cochrane Collaboration’s tool for assessing risk of bias. We considered the possibilities of study design, population, industry sponsorship, selection bias, performance bias, detection bias, attrition bias, report bias and publication bias.

Data Synthesis
Performance of search, tabulation of data, and presentation of results were all guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (17). Summary of findings reported include sensitivity, specificity, negative and positive predictive values for each included study in regard to LVOs.

RESULTS
The combined search strategy captured a total of 556 potential articles for review with four of which were added by independent hand search (Figure 1). Duplicates were removed yielding a total of 519 articles. Abstract screening was conducted which identified 41 articles satisfying inclusion criteria. The remaining 41 articles had a full manuscript review, 11 articles were selected for review by a consensus committee. After applying inclusion and exclusion criteria only 8 articles remained.

Full manuscript review of 11 articles was done by an expert panel (all authors) for final inclusion in the evaluation. Three articles were excluded from the study after discussion due to: (1) a lack of confirmatory imaging of LVO (18); (2) evaluating only a small segment of a one vessel source of LVO and not a whole distribution (19); and (3) a retrospective reevaluation of a prospective study already included (20). Thus, a total of 8 manuscripts were included in the final analysis.

The studies identified by the inclusion/exclusion criteria are listed in Table 1. Studies originated in the United States, Brazil, Spain, Australia, and Denmark. Identified studies were noted to have significant variability in study design with six being retrospective cohort studies and two of these having a prospective validation cohort (11,12,14,15,21). Another utilized the full NIHSS scale and was a prospective observational study performed by prehospital flight crews (22).
Bias Analysis

As noted above, studies originated in different regions including the United States, Brazil, Australia, Spain, and Denmark where EMS and hospital care systems may vary (Table 1). With the recognition that bias is possible in these studies, a complete assessment for bias is noted in Table 2.

Two areas where the identified studies demonstrated significant variability were in (1) the population of patients assessed, and (2) the methods used to detect LVO. Populations were selected were inconsistent with some studies focusing only on anterior circulation involvement (11,12,15), whereas others include both anterior and posterior circulation (Table 2). The detection of LVO also varied between the studies with one using multiple modalities for identification including CT angiogram, transcranial duplex ultrasound, and MRI (12) while the other used transcranial Doppler as part of the assessment (11). Others did not clearly document a systematic process for LVO identification other than the use of advanced imaging.

In the assessment of other types of bias, many studies did not have EMS personnel obtaining primary data points but were retrospective evaluations of NIHSS elements from registries or prospective studies. This method introduced bias since these scales are being designed for prehospital identification of LVO and this group of providers was not involved in the direct data collection.

Anterior and Posterior Circulation LVO Identification

Multiple studies examined LVO identification in patient populations with either anterior and/or posterior circulation involvement (Table 3). Kesinger et al. (22) utilized the NIH stroke scale and demonstrated the lowest sensitivity at 52% with a high specificity at 87% with a NIHSS ≥ 12. This study was conducted through data collected by prehospital providers.

The CPSSS scale performance (13,14,23) varied greatly between the three evaluations conducted with a sensitivity of 55% and specificity of 85% by Lima et al. (13), 70% sensitivity and 87% specificity by Kummer et al., and 83% sensitivity and 40% and specificity by Katz et al. (14).

The other scales evaluating anterior and posterior LVO (PASS, LAMS, RACE, and FAST-ED) all performed similarly with sensitivity ranging from 55%–64% and specificity ranging from 83%–89% (Table 3) (11,12,13,21).

Anterior Circulation LVO Identification

Three studies utilized scales for evaluation of anterior circulation LVO only (11,12,15). The LAMS score was originally derived to assess stroke patients for anterior circulation strokes with a higher weight placed on the motor assessment. LAMS ≥4 had a sensitivity of 81% with a high specificity at 89% with an associated PPV of 92% similar to that of the NIHSS of 11 or greater (12). However, in a comparison study which focused only on M1 and proximal M2 occlusion, LAMS ≥4 underperformed with a sensitivity of 66% and specificity of 86% (15).

RACE scores collected by EMS providers for anterior LVO had a sensitivity of 85% with a specificity of 68%. In a more limited LVO evaluation using hospital based data focusing on M1 and proximal M2 occlusion, RACE had a sensitivity of 66% and an increased specificity of 90%.

In Zhao et al., an evaluation of RACE, LAMS, CPSSS, PASS, and FAST-ED was performed demonstrating similar sensitivity and specificity for identification of
### Table 1. Summary of articles satisfying inclusion criteria

<table>
<thead>
<tr>
<th>Study/Primary Scale</th>
<th>Study Design</th>
<th>Location</th>
<th>Selection Criteria</th>
<th>Outcome Measures</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nazliel 2008 (12) LAMS</td>
<td>Retrospective cohort study of consecutive patients</td>
<td>Los Angeles, United States</td>
<td>Last known well &lt;12 hours</td>
<td>Presence of LVO</td>
<td>119</td>
</tr>
<tr>
<td>Lima et al. 2016 (13) FAST-ED</td>
<td>Retrospective evaluation of Prospective Cohort</td>
<td>Sao Palo, Brazil</td>
<td>Admission Non Contrast head CT were obtained</td>
<td>Presence of LVO</td>
<td>741</td>
</tr>
<tr>
<td>Katz et al. 2015 (14) CPSSS</td>
<td>Retrospective study and derivation cohort from NINDS dataset Validation Cohort IMS III dataset</td>
<td>Cincinnati, United States</td>
<td>Patients suffering mild to severe stroke</td>
<td>Primary outcome Identification of Severe stroke NIH &gt;15</td>
<td>624</td>
</tr>
<tr>
<td>Kesinger et al. 2015 (22) NIHSS</td>
<td>Prospective Observational Study using NIHSS performed by Flight crew</td>
<td>Pittsburgh, United States</td>
<td>Patients with diagnosis of stroke transported by HEMS service Excluded Hemorrhages, those missing NIHSS, and Intubated or sedated patients</td>
<td>Ability of NIHSS to predict LVO Correlation of Pre-Hospital NIHSS to Stroke team NIHSS</td>
<td>293</td>
</tr>
<tr>
<td>Perez de la Ossa et al. 2014 (11) RACE</td>
<td>Retrospective Derivation cohort Prospective validation cohort with EMS providers</td>
<td>Barcelona, Spain</td>
<td>Derivation Cohort used NIHSS sections with highest predictive value for LVO Validation Cohort those who had Code Stroke called by EMS or a sending Hospital</td>
<td>Presence of LVO</td>
<td>654</td>
</tr>
<tr>
<td>Hasstrup et al. 2016 (21) PASS</td>
<td>Retrospective Cohort Study</td>
<td>Denmark</td>
<td>Patients receiving tPA or Endovascular therapy receiving CTA or MRI</td>
<td>Presence of LVO</td>
<td>3127</td>
</tr>
<tr>
<td>Kummer 2016 CPSSS Zhao et al. 2017 (15)</td>
<td>Retrospective evaluation of a prospective cohort Retrospective evaluation of prospective cohort</td>
<td>New York, United States Australia</td>
<td>Patients suffering from Proximal M2, M1 and ICA stroke</td>
<td>Presence of narrowly defined LVO</td>
<td>565</td>
</tr>
</tbody>
</table>

the limited anterior LVO only (M1 and proximal M2 occlusion; Table 3) (15).

**Effect on Scale Performance by Source of Data Collection**

Of the scales identified in this evaluation, only the NIHSS and RACE were assessed from data collected from EMS providers. The NIHSS ≥ 12 was found to have the lowest sensitivity at 52% with specificity at 87%.

RACE scores collected by EMS providers had a sensitivity of 85% with a specificity of 68%. In comparison, the other studies identified in this evaluation used data collected primarily from hospital based providers certified in the administration of the NIHSS (e.g., neurologists, emergency physicians, nurses).

RACE scale performance in this setting varied from that collected by EMS providers with a sensitivity of 55% and specificity of 87%.

**DISCUSSION**

In this evaluation, we identified eight manuscripts that evaluated prehospital scales for LVO detection. There was significant heterogeneity among these studies as noted in the bias assessment making direct comparisons of stroke scale performance of LVO detection difficult. RACE and NIHSS were evaluated through assessments made by prehospital providers with RACE having a sensitivity of 85% and specificity of 68% for anterior LVO. In contrast, LAMS, CPSSS, and FAST-ED were all assessed through NIHSS elements from registry and trial populations and it is unclear...
<table>
<thead>
<tr>
<th>Study and Scale Assessed</th>
<th>Design</th>
<th>Population</th>
<th>Industry affiliations</th>
<th>Selection Bias</th>
<th>Performance Bias</th>
<th>Detection Bias</th>
<th>Attrition Bias</th>
<th>Reporting Bias</th>
<th>Other Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naziel et al. 2008 (12)</td>
<td>LAMS</td>
<td>Mild Ischemic Stroke, only Anterior Circulation</td>
<td>None</td>
<td>Severe Only anterior circulation; UCLA Stroke Center and GWTG Stroke Registry 2015</td>
<td>Mild Retrospective</td>
<td>Mild Multiple modalities with different sensitivity for LVO</td>
<td>None</td>
<td>None</td>
<td>Moderate</td>
</tr>
<tr>
<td>Lima et al. 2016 (13)</td>
<td>FAST-ED CPSSS NIHSS RACE</td>
<td>None Ischemic Stroke Anterior or Posterior Circulation</td>
<td>Yes Multiple authors with disclosure with industry funding</td>
<td>Mild STOP Stroke cohort</td>
<td>None</td>
<td>None</td>
<td>Moderate</td>
<td>Moderate</td>
<td>None</td>
</tr>
<tr>
<td>Katz et al. 2015 (14)</td>
<td>CPSSS</td>
<td>None Ischemic Stroke Anterior and/or Posterior Circulation</td>
<td>No</td>
<td>Mild Validation study in IMS-III with NIHSS 8–40</td>
<td>Mild Retrospective</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Moderate</td>
</tr>
<tr>
<td>Kesinger et al. 2015 (22) NIHSS</td>
<td>None Ischemic strokes both anterior and posterior circulation</td>
<td>None</td>
<td>Mild Only HEMS</td>
<td>Moderate only patients treated by flight crews</td>
<td>Moderate LVO advanced imaging type not specified</td>
<td>Moderate 99/404 of the reporting cohort had no NIHSS</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Perez de la Ossa et al. 2014 (11) RACE</td>
<td>None Ischemic Stroke, only Anterior Circulation</td>
<td>None</td>
<td>Severe Only anterior circulation</td>
<td>None</td>
<td>Moderate LVOs imaging after Trans cranial Doppler</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Hastrup et al. 2016 (21) PASS 3SS LAMS CPSSS RACE</td>
<td>None Ischemic Stroke Anterior or posterior circulation</td>
<td>Yes Funding from Laerdal and Lundbeck Foundation</td>
<td>Severe Danish Stroke Registry who all received tPA</td>
<td>None</td>
<td>None</td>
<td>Moderate 47% patients excluded due to missing data</td>
<td>Mild Included derivation cohort in comparison with other stroke scales</td>
<td>Moderate</td>
<td></td>
</tr>
</tbody>
</table>

(Continued on next page)
how these scales will perform for LVO detection in the out-of-hospital setting. At this time, further evaluations
must be done in the prehospital setting to determine
the ease of use and true sensitivity and specificity of
these scales in identifying LVO.

Full NIHSS, PASS, FAST, and CPSSS were designed
to detect LVOs in anterior and posterior circulation.
The full NIHSS scale performed by prehospital flight
crews may not be comparable to the typical EMS per-
sontal. In some cities or locations close to a hospi-
tal with short transport times, a full NIHSS may not
even be achievable. The PASS and FAST-ED assess-
ments, although both have strong specificity (83% and
89% respectively), may lack necessary sensitivity (61%
and 66%, respectively). This may be a challenge in the
United States where a balance may be needed between
a high over triage with high delivery of non-LVOs to
interventional facilities versus delivery to the nearest
appropriate facility. The scales were also primarily reg-
istry data and still need to be validated in the real world
prehospital setting. CPSSS initially showed promise to
reduce false negatives with a higher sensitivity of 83%.
However, further assessment by Zhao et al. and Lima
et al. (13, 15) only showed a sensitivity of 56% using
CPSSS. In a different dataset validation of the CPSSS,
Kummar et al. demonstrated that at a set cut off of >=
2 there was still high sensitivity 70% and specificity at
87 (23). Due to the significant performance differences
in these scales, it is imperative to reassess their valid-
ity in the prehospital setting by typical EMS providers
across multiple regions.

Perez de la Ossa et al. validated RACE in the prehos-
pital setting and demonstrated a sensitivity of 85% (11).
This was later assessed in a hospital setting by multi-
ple groups where its sensitivity performance was only
55%–66% (13,15,21). There are multiple biases, includ-
ing providers and populations considered that may
contribute to these differences. The initial study was
the most appropriate given it was performed by pre-
hospital providers, but the difference does bring cause
for concern to reevaluate in future prehospital studies.

The LAMS scale, although used for many years for
stroke identification, has not been evaluated for LVO
detection in a population of prehospital providers.
It was assessed using hospital registry data and was
both highly sensitive and specific when looking at its
potential for diagnosing LVOs. This makes it attractive
as a prehospital diagnostic tool for LVOs. The initial
validation demonstrated a sensitivity of 81% identifi-
cation of LVO’s in the anterior circulation. However,
a subsequent assessment by Zhao et al. demonstrated
a much lower sensitivity of 66% (15) in only ante-
rior circulation strokes. When including the posterior
circulation, as done by Hastrup et al., the sensitivity
dropped to 57% (21). With these results, this scale
needs further validation and data supporting its use
by prehospital providers.

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<th>Attrition Bias</th>
<th>Reporting Bias</th>
<th>Other Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kummer 2016 CPSSS</td>
<td>Retrospective evaluation of cohort</td>
<td>Assessment of ICA, M1, M2 and Basilar Stroke Registry</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Moderate Not EMS obtained</td>
<td></td>
</tr>
<tr>
<td>Zhao et al. 2017 (15) RACE</td>
<td>Retrospective evaluation of cohort</td>
<td>Assessment of ICA, M1 and proximal M2</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Moderate Not EMS obtained</td>
<td></td>
</tr>
<tr>
<td>Zhao et al. 2017 (15) LAMS FAST-ED CPSSS</td>
<td>Retrospective evaluation of cohort</td>
<td>Assessment of ICA, M1 and proximal M2</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
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circulation, as done by Hastrup et al., the sensitivity
dropped to 57% (21). With these results, this scale
needs further validation and data supporting its use
by prehospital providers.
### Table 3. Summary of findings from each article reviewed

<table>
<thead>
<tr>
<th>Study</th>
<th>Prehospital Stroke Scale</th>
<th>Ischemic Stroke Included</th>
<th>Provider Collecting Scale Items</th>
<th>N</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Prevalence of LVO in population (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14Katz et al. 2015 (14)</td>
<td>CPSSS ≥ 2</td>
<td>Anterior or Posterior circulation</td>
<td>Hospital</td>
<td>303</td>
<td>83</td>
<td>40</td>
<td>73</td>
<td>84.0*</td>
<td>70*</td>
</tr>
<tr>
<td>22Kesinger et al. 2015 (22)</td>
<td>HEMS-NIHSS ≥ 12</td>
<td>Anterior or Posterior circulation</td>
<td>EMS</td>
<td>293</td>
<td>52</td>
<td>87</td>
<td>72</td>
<td>80.5†</td>
<td>42*</td>
</tr>
<tr>
<td>21Hastrup et al. 2016 (21)</td>
<td>HEMS-NIHSS ≥ 12</td>
<td>Anterior or posterior circulation</td>
<td>Hospital</td>
<td>3127</td>
<td>49</td>
<td>94</td>
<td>35</td>
<td>88.5‡</td>
<td>42*</td>
</tr>
<tr>
<td>Lima et al. 2016 (13)</td>
<td>FAST-ED ≥ 4</td>
<td>Anterior or Posterior Circulation</td>
<td>Hospital</td>
<td>727</td>
<td>61</td>
<td>89</td>
<td>33</td>
<td>72.0</td>
<td>82</td>
</tr>
<tr>
<td>Kummer 2016</td>
<td>LAMS ≥ 2</td>
<td>Anterior or posterior circulation</td>
<td>Hospital</td>
<td>664</td>
<td>70</td>
<td>87</td>
<td>12‡</td>
<td>42.0*</td>
<td>95*</td>
</tr>
<tr>
<td>Nazliel et al. 2008 (12)</td>
<td>LAMS ≥ 11</td>
<td>Anterior Circulation</td>
<td>Hospital</td>
<td>119</td>
<td>81</td>
<td>89</td>
<td>62</td>
<td>92.0*</td>
<td>74*</td>
</tr>
<tr>
<td>11Perez de la Ossa et al. 2014 (11)</td>
<td>RACE ≥ 5</td>
<td>Anterior Circulation</td>
<td>EMS</td>
<td>357</td>
<td>85</td>
<td>68</td>
<td>21</td>
<td>42.0</td>
<td>94</td>
</tr>
<tr>
<td>Zhao et al. 2017 (15)</td>
<td>NIHSS ≥ 11</td>
<td>Anterior Circulation</td>
<td>Hospital</td>
<td>565</td>
<td>88</td>
<td>72</td>
<td>15</td>
<td>46.0*</td>
<td>96*</td>
</tr>
<tr>
<td>11Perez de la Ossa et al. 2014 (11)</td>
<td>RACE ≥ 5</td>
<td>Anterior Circulation</td>
<td>EMS</td>
<td>357</td>
<td>85</td>
<td>68</td>
<td>21</td>
<td>42.0</td>
<td>94</td>
</tr>
<tr>
<td>Zhao et al. 2017 (15)</td>
<td>NIHSS ≥ 11</td>
<td>Anterior Circulation</td>
<td>Hospital</td>
<td>565</td>
<td>88</td>
<td>72</td>
<td>15</td>
<td>46.0*</td>
<td>96*</td>
</tr>
</tbody>
</table>

For each study, the provider who originally collected scale items (e.g. motor function, facial asymmetry or aphasia) is listed as being collected by EMS or hospital based providers.

*Not reported in original publication. These values were calculated from reported sensitivity, specificity and prevalence.

†Reported values which differ from calculated values of positive predictive value given prevalence, sensitivity and specificity.

‡Reported value differs from calculated value of prevalence given total population analyzed and number of patients with detected LVOs by imaging.
Limitations

This review was limited by the lack of data addressing the prehospital assessment of LVO in stroke patients. While there are other scales that may address stroke severity and even LVOs, we only included those studies that were directly addressing the prehospital providers, had confirmatory imaging, did not limit the occlusion to a single section of a vessel (18,19,20,24). These strict criteria were an attempt to reduce the variability and applicability of sensitivity and specificity for LVO to the EMS provider. It is possible that the scales above may be sufficient for the prehospital provider in detecting LVOs. Currently, the American Heart Association and the American Stroke Association calls for the potential identification of large vessel occlusions in the prehospital setting to guide patient care to facilities where interventions may be conducted (9). These scales can assist in identification; however, close monitoring of over-triage will need to be done. Future evaluation would be necessary prior to widespread adoption on one scale by EMS, especially if it is to be considered for diversion of patients to appropriate hospitals for management of varying degrees of stroke.

While the PPV and NPVs were included in this study, it is important to consider that the prevalence of the disease in each study varied from 12% to 73%, which could significantly affect applicability of these scales to the general population. In a large Harvard registry of stroke, only 34% of strokes harbored a LVO (25). For those studies with a much higher prevalence such as Naziel et al., Katz et al., and Kesinger et al. (12, 14, 22), there may be a bias toward higher overall sensitivity.

We must also consider that the definitions of LVOs were not uniformly consistent in these identified manuscripts. These conservative versus liberal definitions of LVO affects the performance of each scale making direct comparisons difficult (Table 2 and Table 3). Furthermore, due to the variability of definitions, a meta-analysis to evaluate individual scale performance is not possible at this time. Future work will need to address the best possible definition for large vessel occlusion such that consistent data collection and evaluation of prehospital scales can be done.

CONCLUSION

Currently, there is limited evidence that prehospital stroke scales provide sufficient sensitivity and specificity in the prehospital arena. While one data set or derivation may have shown promise at detecting LVOs, when comparing the literature as a whole there was often significant disagreement between studies. To take advantage of the benefit of stroke interventions as reported by studies such as MR CLEAN, SWIFT PRIME, and EXTEND IA, it is essential to prove a reliable method for the identification of large vessel occlusions in the typical prehospital setting (26–28). As such, we must rely on our prehospital providers’ ability to assess for LVOs, making it essential to continue research in the out-of-hospital setting. The results presented here identify several potential tools for our EMS providers, but more research is necessary to ensure reliability to minimize the risk associated with misclassification.

References


10. Blackham KA, Meyers PM, Abruzzo TA, Albuquerque FC, Fiorella D, Fraser J, Frei D, Gandhi CD, Heck DV,


