Stroke Recognition for First Aid Providers: A Systematic Review and Meta-Analysis

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Abstract

Aim

To perform a systematic review of the literature on the effectiveness of existing stroke recognition scales used in a prehospital setting and suitable for use by first aid providers. The systematic review will be used to inform an update of international first aid guidelines.

Methods

We followed the Cochrane Handbook for Systematic Reviews of Interventions methodology and report results according to PRISMA guidelines. We searched Medline, Embase and CENTRAL on May 25, 2020 for studies of stroke recognition scales used by first aid providers, paramedics and nurses for adults with suspected acute stroke in a prehospital setting. Outcomes included change in time to treatment, initial recognition of stroke, survival and discharge with favorable neurologic status, and increased layperson recognition of the signs of stroke. Two investigators reviewed abstracts, extracted and assessed the data for risk of bias. The certainty of evidence was evaluated using GRADE methodology.

Results

We included 24 observational studies with 10,446 patients evaluating 10 stroke scales (SS). All evidence was of moderate to very low certainty. Use of the Kurashiki Prehospital SS (KPSS), Ontario Prehospital SS (OPSS) and Face Arm Speech Time SS (FAST) was associated with an increased number of suspected stroke patients arriving to a hospital within three hours and, for OPSS, a higher rate of thrombolytic therapy. The KPSS was associated with a decreased time from symptom onset to hospital arrival. Use of FAST Emergency Response (FASTER) was associated with decreased time from door to tomography and from symptom onset to treatment. The Los Angeles Prehospital Stroke Scale (LAPSS) was associated with an increased number of correct initial diagnoses. Meta-analysis found the summary estimate sensitivity of four scales ranged from 0.78 to 0.86. The FAST and Cincinnati Prehospital Stroke Scale (CPSS) were found to have a summary estimated sensitivity of 0.86, 95% CI [0.69-0.94] and 0.81, 95% CI [0.70-0.89], respectively.

Conclusion

Stroke recognition scales used in the prehospital first aid setting improves the recognition and diagnosis of stroke, thereby aiding the emergency services to triage stroke victims directly down an appropriate stroke care pathway. Of those prehospital scales evaluated by more than a single study, FAST and Melbourne Ambulance Stroke Screen (MASS) were found to be the most sensitive for stroke recognition, while the CPSS had higher specificity. When blood glucose cannot be measured, the simplicity of FAST and CPSS makes these particular stroke scales appropriate for non-medical first aid providers.

Introduction

Stroke is one of the leading causes of death and disability worldwide [1]. The early detection of stroke in the prehospital setting has the potential to improve stroke outcomes by decreasing delays in treatment. A variety of stroke assessment scales have been developed for both in-hospital and prehospital use. Stroke scales designed for the prehospital setting have a lower number of diagnostic criteria, easy-to-identify clinical signs and simplicity of implementation, making them applicable for use by first aid providers and lay persons. In 2015, the International Liaison Committee on Resuscitation (ILCOR) published a Consensus on Science with Treatment Recommendations (CoSTR), suggesting a benefit from the first aid use of stroke recognition scoring systems or scales for individuals with suspected acute stroke [2, 3].

The objective of this systematic review was to synthesize the evidence for the diagnostic accuracy and clinical effectiveness of stroke scales applied by laypeople, paramedics and nurses in a prehospital setting, according to the research question: Among adults with suspected acute stroke, does the use of a rapid stroke scoring system or scale, compared with basic first aid assessment without the use of a scale, change time to...
Materials And Methods

This systematic review was conducted in accordance with the Cochrane Handbook for Systematic Reviews of Interventions [4], and reporting occurred through the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist [5]. This review will inform the International Liaison Committee on Resuscitation (ILCOR) consensus on science and treatment recommendations for stroke recognition.

Eligibility criteria and outcomes

The population included adults over 18 years old, suspected of having a stroke in the prehospital setting, regardless of its type or severity, including ischemic stroke, hemorrhagic stroke or transient ischemic attack (TIA). We excluded all patients with trauma.

The intervention/index test was the use of a single, rapid stroke scale during primary patient assessment to diagnose stroke, as used by a first aid provider, paramedic or nurse. We excluded studies where stroke scales were applied in an emergency department, or assessments made by general practitioners or neurologists. We also excluded stroke scales intended to assess for large vessel occlusion as these were felt to be beyond the skill of a lay first aid provider.

Comparison groups included suspected stroke patients, managed by first aid providers, paramedics or nurses in the prehospital setting who did not use a stroke scale during the primary assessment. To measure the diagnostic accuracy of stroke scales, studies compared the stroke scale result to the hospital diagnosis of stroke as a reference test. An in-hospital diagnosis of stroke was a confirmed documented physician or imaging diagnosis.

The critical outcome was the time to treatment. This outcome included the proportion of patients whose time from symptom onset to hospital arrival or treatment was within two or three hours, time from symptom onset to arrival in the emergency department or hospital, time between hospital arrival to computed tomography (CT) head scan or other imaging (‘door’ to imaging) and time from symptom onset to administration of tissue Plasminogen Activator (tPA) or the use of endovascular reperfusion techniques.

For the important outcome of recognition of stroke, two types of data studies were eligible: clinical efficacy studies, assessing the proportion of patients receiving appropriate treatment, and diagnostic accuracy studies. Other important outcomes were discharge with favorable neurologic status, survival with favorable neurologic outcome, and cognitive knowledge. The latter outcome evaluated whether stroke recognition scales improve first aid provider recognition of signs of stroke.

Study designs

Randomized controlled trials (RCTs) and non-randomized studies (non-randomized controlled trials, interrupted time series, controlled before-and-after studies, cohort studies, diagnostic test accuracy studies) were eligible for inclusion. Unpublished studies, conference abstracts, trial protocols and posters were excluded. All languages were included as long as there was an English abstract.

Information sources and search strategy

We included studies from the 2015 International Liaison Committee on Resuscitation (ILCOR) consensus on first aid science with treatment recommendations (CoSTR) systematic review of stroke assessment scales [2, 3]. The existing search strategy, previously run from inception through January 15, 2015, was re-run in MEDLINE (PubMed interface), EMBASE (Embase interface), and the Cochrane Central Register of Controlled Trials (CENTRAL) from January 1, 2014 to September 29, 2019 (Appendix A). The search was re-run on May 25, 2020. Additional studies were identified through a hand search of reference lists from included studies.

After removal of duplicates, two authors (PC, DM) independently screened titles and abstracts for relevance. Full texts of potentially relevant publications were retrieved and evaluated by the same reviewers, independently. Papers judged to be relevant were included and reasons for exclusion were documented. Discrepancies between the reviewers were resolved by discussion with the ILCOR First Aid Task Force. Inter-rater reliability was measured with Cohen’s kappa at the title and abstract stage and the full text article stage [6].

Data collection

We used a prespecified data extraction form to collect the following data from included studies: number of participants, age, study characteristics (study design, country, inclusion and exclusion criteria), intervention, training method, reference standard for diagnostic studies, outcome measures and findings. Where possible, missing values were calculated from the available data. For diagnostic studies, we extracted 2 x 2 data (true positives, false positives, true negatives and false negatives) directly for each index test.

Risk of bias and certainty of evidence assessment

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For observational studies, the risk of bias (ROB) and certainty of evidence for each individual study was assessed using the Risk Of Bias In Non-randomized Studies of Interventions (ROBINS-I) tool [7]. For diagnostic studies, we assessed the risk of bias of each study using the Quality Assessment of Diagnostic Accuracy Studies version 2 (QUADAS-2) tool [8]. A study was considered at high risk of bias if one of the domains within the ROBINS-I tool or QUADAS-2 tool identified high risk of bias. The Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology was used to determine the certainty of evidence for the body of evidence across outcomes [9]. In the GRADE approach, the certainty of evidence can be high, moderate, low or very low. Observational studies assessed with the ROBINS-I tool and diagnostic test accuracy studies assessed with the QUADAS-2 tool start with a high level of certainty [7, 10, 11] and can be downgraded across five domains (limitations in study design, imprecision, indirectness, heterogeneity and publication bias), and upgraded across three domains (large magnitude of effect, dose-response and residual plausible bias and confounding).

Data analysis
Continuous outcomes are reported as mean differences (MD) with 95% confidence intervals (CIs). Dichotomous outcomes are reported as risk ratios (RR) with 95% CIs. There was insufficient data to conduct meta-analyses of effectiveness data. For diagnostic studies, all scales used the same positivity threshold of 'one or greater', which indicates that the person was considered to have a stroke with one or more positive criteria. For each index test, we generated a diagnostic $2 \times 2$ table (true positives, false positives, true negatives and false negatives) from which we calculated sensitivity and specificity with 95% confidence intervals (CI). When more than one study was identified per scale, we calculated a summary point estimated sensitivity and specificity using a random effects meta-analysis and created Summary Receiver Operating Characteristic (SROC) plots to show the variation in test accuracy estimates across studies with Review Manager 5.3 (RevMan 5.3, The Nordic Cochrane Centre, Copenhagen, Denmark, 2014). Parameter values required by Review Manager Software to construct plots in the SROC space were calculated with MetaDTA: Diagnostic Test Accuracy Meta-Analysis website, version 1.25 (https://crsu.shinyapps.io/dta_ma/) [12].

Results
For the literature search and study selection, an updated search strategy from 2014 to 2019 and a rerun search strategy from 2019 to 2020 identified 1814 unique titles/abstracts. In addition, we identified new studies and 24 from the previous 2015 search results for the 2015 ILCOR CoSTR for first aid stroke assessment [2]. Based on title and abstract screening, we excluded 1768 studies (reviewer agreement was 95.15%, Kappa = 0.44). Of the 78 full-text articles reviewed, a further 54 were excluded (reviewer agreement was 99.87%, Kappa = 0.79). We ultimately included a total of 24 studies (Figure 1).
FIGURE 1: PRISMA diagram (diagram illustrating the flow of articles throughout the selection procedures)

CoSTR: Consensus on Science with Treatment Recommendations; FATF: First Aid Task Force; ILCOR: International Liaison Committee on Resuscitation; PRISMA: Preferred reporting items for Systematic Reviews and Meta-Analyses.

Study characteristics

Characteristics of the included studies are summarized in Table 1. Excluded studies with reasons are presented in Appendix B. We included 24 observational studies; 13 were prospective [13-25], and 11 were retrospective studies [26-36]. Five studies assessed time to treatment or recognition of stroke outcomes [20, 25, 24, 32, 34]; 18 studies assessed the diagnostic accuracy of stroke recognition scales [13-22, 30-32, 35, 36] and one study assessed both time to treatment and diagnostic accuracy [29]. Four studies investigated the "Face, Arm, Speech, Time (FAST)" scale [14, 17, 21, 27]; five studies investigated the "Los Angeles Prehospital Stroke Scale (LAPSS)" [14-16, 18, 26]; 12 studies investigated the "Cincinnati Prehospital Stroke Scale (CPSS)" [14, 15, 19, 22, 25, 26, 28, 30-32, 35, 36], and three studies investigated the "Melbourne Ambulance Stroke Screen (MASS)" scale [14, 15, 28]. The "Face, Arm, Speech, Time, Emergency Response Protocol (FASTER)" scale, "Ontario Prehospital Stroke Scale (OPSS)", "Kurashiki Prehospital Stroke Scale (KPSS)", "Recognition of Stroke in the Emergency Room (ROSIER)" scale, "Medic Prehospital Assessment for Code Stroke (MedPACS)" and "Balance, eyes, FAST (BeFAST)" and "Prehospital Ambulance Stroke Test (PreHAST)" were investigated by one study each [15, 17, 20, 21, 29, 34, 36]. One study investigated education in stroke signs and symptoms [23]. Sixteen studies investigated only one scale [13, 16, 18-20, 22, 24, 25, 27, 29-33] and seven studies investigated two or more scales [14, 15, 17, 21, 26, 28, 36]. The characteristics of stroke recognition scales evaluated in these studies are described in Table 2.
| Author, Year | Study Design | Description | Criteria | Scales | Standard Use | Administrator | Training | Outcomes |
|--------------|--------------|-------------|----------|--------|--------------|---------------|----------|----------|
| Andsberg et al. (2017) [13] | Prospective observational study | Hässleholm, Sweden. N = 69, mean age not reported. | Inclusion: suspicion of stroke, defined as sudden onset of focal neurologic symptoms/signs, in conscious people > 18 years of age. | PreHAST | After reviewing medical records by two stroke physicians. | Ambulance nurses | Four-hour education program including practical training under supervision and proper execution. | Diagnostic accuracy |
| Asimos et al. (2014) [26] | Retrospective observational, cross-sectional study | North Carolina, US. N = 2442. Mean age = 66 years (CPSS) and 69 years (LAPSS). 25.2% men. | Inclusion: preliminary EMS impression of stroke. Exclusion: patients with duplicate data records and patients who were transferred between facilities. | CPSS, LAPSS | ED diagnosis of stroke, used ICD 9/10 codes without any other detail. | Paramedics | Not reported | Diagnostic accuracy |
| Bergs et al. (2010) [14] | Prospective observational cross-sectional study | Leuven, Belgium. N = 135. Mean age > 77 years. 61% men. | Inclusion: all adults transported with relevant neurologic complaints. Exclusion: ages < 18 years, GCS < 9, transported to alternate hospital, trauma, form filled. | FAST, CPSS, LAPSS, MASS | Unspecified, diagnosis at ED discharge. | Emergency nurses | Briefing on purpose of study, stroke scales and guidelines | Diagnostic accuracy |
| Berglund et al. (2014) [27] | Retrospective observational study | Stockholm, Sweden. N = 900. Range age = 22-93 years. 55.5% men. | Inclusion: all persons from 18 to 85 years suspected of having a stroke with onset within six hours and with independence in activities of daily living. | FAST | Diagnosis of stroke after imaging, neurologic exam, EEG, laboratory tests. All participants received a final diagnosis by a neurologist or stroke specialist. | Paramedics | One lecture about stroke test prior to the start of the study. | Diagnostic accuracy |
| Bray et al. (2005) [15] | Prospective observational cross-sectional study | Melbourne, Australia. N = 100. | Inclusion: preliminary EMS impression of stroke or suspicion of stroke by dispatchers. Exclusion: not reported. | CPSS, LAPSS, MASS | Diagnosis of stroke at discharge (stroke/TIA registry) | Paramedics | One-hour educational session, and instruction in assessment and documentation of items used in a prehospital stroke scale. | Diagnostic accuracy |
| Bray et al. (2010) [28] | Retrospective observational Study | Melbourne, Australia. N = 850. | Inclusion: patients with suspicion of stroke and TIA. Exclusion: patients who were unconscious or asymptomatic at the time of paramedic assessment. | CPSS, MASS | Stroke/TIA registry to determine if the discharge diagnosis was stroke or TIA. | Paramedics | One-hour stroke education program and instruction in the use of MASS. | Diagnostic accuracy |
| Beijing, China. N = 1130. Age | Inclusion: patients suspected of stroke and TIA. Absence | | | | | | 180 min training | |
| Study Reference               | Study Type                        | Location                | Sample Size | Inclusion Criteria                                                                                           | Discharge Diagnosis | Study Team                  | Diagnostic Accuracy                      |
|------------------------------|-----------------------------------|-------------------------|-------------|-------------------------------------------------------------------------------------------------------------|---------------------|-----------------------------|------------------------------------------|
| Chen et al. (2013) [16]      | Prospective observational study   | Rotterdam, Netherlands  | N = 310     | Participants with symptoms suggesting an acute neurologic problem. Exclusion: trauma and no neurological complaints. | LAPSS               | Paramedics                  | 90-minute training session on stroke screening tool prior to implementation. |
| English et al. (2018) [30]   | Retrospective observational study | United Kingdom, UK      | N = 130     | Participants with age > 18 years presenting with symptoms of stroke. Exclusion: age < 18 years, patients without ROSIER scale in assessment or transfer to another hospital. | CPSS                | Paramedics                  | One-hour online module annually on stroke recognition and assessment. |
| Fothergill et al. (2013) [17]| Prospective observational study   | United Kingdom, UK      | N = 265     | Participants transported by EMS and having possible stroke or TIA. Exclusion: unresponsive patient.           | FAST, ROSIER        | Paramedics                  | One-hour stroke educational program, scenario-based demonstration of ROSIER and 15-minute educational DVD. |
| Frendl et al. (2009) [31]    | Retrospective observational study | United Kingdom, UK      | N = 154     | Participants seen with the admitting diagnosis of stroke and onset of symptoms was < 6 hours.               | CPSS                | Paramedics                  | One-hour interactive educational presentation on stroke recognition and use of the CPSS. |
| Greenberg et al. (2017) [32] | Retrospective observational study | United Kingdom, UK      | N = 305     | Participants seen with the admitting diagnosis of stroke and onset of symptoms was < 6 hours.               | CPSS                | Paramedics                  | Training courses on CPSS during ACLS training. |
| Harbison et al. (2003) [33]  | Retrospective observational study | United Kingdom, UK      | N = 225     | Participants seen with the admitting diagnosis of stroke and onset of symptoms was < 6 hours.               | CPSS                | Paramedics                  | Training package (lecture notes, slide presentation, handout, and multiple choice) |

**Notes:**
- LAPSS: Late Assessment Performance Score System
- CPSS: Canadian Prehospital Stroke Scale
- OPSS: Oregon Prehospital Stroke Scale
- FAST: Fast Aphasia Screening Test
- ROSIER: Rapid Onset Stroke Identification and Early Referral
- tPA: Tissue Plasminogen Activator
| Study | Design | Location | N | Mean Age | Inclusion | Paramedics | Score | Training | Diagnostic Accuracy |
|-------|--------|----------|---|----------|-----------|------------|-------|----------|---------------------|
| Iguchi et al. (2010) [34] | Retrospective observational study | Kurashiki city, Japan. N = 30. Mean age = 73 years. 61.9% men. |  |  | Inclusion: consecutive patients transferred to hospital by paramedics finally diagnostic as having an acute stroke or TIA within 24 h of onset. | | KPSS | 90-min training session | | |
| Kidwell et al. (2000) [18] | Prospective observational study | Los Angeles, US. N = 206. Mean age = 63 years. 52% male. |  |  | Final diagnosis of stroke at hospital after a review of reports, imaging and physician notes. | | LAPSS | One-hour initial training session with video and a LAPSS certification. | | |
| Kim et al. (2017) [19] | Prospective observational study | Busan, Republic of Korea. N = 268. |  |  | Final diagnosis of stroke or TIA (no other mention). | | CPSS | Not reported | | |
| Kothari et al. (1999) [25] | Prospective observational study | Cincinnati, United states. N = 171. Mean age = 57.8 years. 72% men. |  |  | Inclusion: patients with stroke, TIA, a stroke-mimicking condition, or a combination of these conditions or patients with other neurologic disorders recruit in an ED service and neurology service. | | CPSS | 10-minute review on how to perform CPSS with paramedics and EMTs. Only verbal instructions were given. | | |
| O'Brien et al. (2012) [20] | Prospective observational study | Gosford, Australia. N = 115. |  |  | Inclusion: all patients with an initial diagnostic of acute stroke. | | FASTER | Information about implementation FAST protocol. | |
| Study | Design | Location | Population Details | Inclusion | Exclusion | Diagnostic Tool | Provider Training | Diagnostic Accuracy |
|-------|--------|----------|--------------------|-----------|-----------|----------------|-------------------|---------------------|
| Pickham et al. (2019) [21] | Prospective observational study | Santa Clara County (California), US. N = 359. | Inclusion: patients with sudden onset of neurological symptoms < 6 hours from EMS arrival were assessed. Exclusion: patients presenting directly to the ED. | FAST, BEFAST | The patient's final diagnosis based on chart review by experienced stroke nurses at each participating hospital. | Paramedics One-hour training video. | Diagnostic accuracy |
| Ramanujam et al. (2008) [35] | Retrospective observational study | San Diego, United states. N = 1045. | Inclusion: patient with acute stroke identification by EMD or paramedics and age > 18 years. Exclusion: patients who were taken to other acute care hospitals, not transported by City EMS agency or with no final outcome data. | CPSS | Stroke team diagnostic or hospital discharge diagnostic. | Paramedics Not reported | Diagnostic accuracy |
| Studnek et al. (2013) [36] | Retrospective observational study | Charlotte, North Carolina. N = 416. Mean average age = 66.8 years. 45.7% male. | Inclusion: suspected stroke or TIA patients who received a prehospital MedPACS screen and were transported to one of the seven local hospitals. Exclusion: age < 18 years, unconscious, seizures, no documented assessment, secondary transports. | CPSS, MedPACS | Stroke diagnosis at hospital discharge. | Nurses 2-hour continuing education lecture regarding neurologic emergencies. | Diagnostic accuracy |
| Vanni et al. (2011) [22] | Prospective observational study | Firenze, Roma, and Pescara, Italy. N = 155. Mean age = 72 years. 59% men. | Inclusion: presence at triage of acute focal neurological deficits or a local EMS dispatch for suspected stroke. Exclusion: major trauma and coma (GCS < 8). Patients with terminal illnesses (life expectancy < 3 months). | CPSS | Stroke diagnoses were established by a consensus of three experts after reviewing all clinical data and imaging results. | Nurses Not reported. | Diagnostic accuracy |
| Wall et al. (2008) [23] | Prospective observational study | Massachusetts, Boston, United states. Age = 40 to 64 years. | Inclusion: Women from the Well-Integrated Screening and Evaluation for Women Across the Nation (WISEWOMAN). | FAST | None Lay public Education session with 3-minute animation to teach the signs of stroke. | Knowledge changes immediately after 3-month training. | Diagnostic accuracy |
Wojner-Alexandrov et al. (2005) [24] - Prospective observational study

Houston, United States. N = 446. Mean age = 69 years. 44% male.

Inclusion: stroke suspected in adults by the dispatcher or EMS provider in the field. Exclusion: none.

LAPSS Final discharge diagnostic (definitive diagnostic determined by neurologist).

Paramedics

Inclusion: stroke suspected in adults by the dispatcher or EMS provider in the field. Exclusion: none.

Final discharge diagnostic (definitive diagnostic determined by neurologist).

Paramedics

Inclusion: stroke suspected in adults by the dispatcher or EMS provider in the field. Exclusion: none.

Final discharge diagnostic (definitive diagnostic determined by neurologist).

Paramedics

Diagnostic accuracy. Time to symptom onset to ED arrival. Paramedic transport times. Time to ED arrival to CT interpretation. Treatment with intravenous tPA.

### TABLE 1: Characteristics of published meta-analyses

| Study                  | Setting               | Inclusion                                                                 | Final discharge diagnostic | Paramedics                                                                 |
|------------------------|-----------------------|---------------------------------------------------------------------------|----------------------------|-----------------------------------------------------------------------------|
| Wojner-Alexandrov et al. (2005) [24] | Houston, United States. N = 446. Mean age = 69 years. 44% male. | Stroke suspected in adults by the dispatcher or EMS provider in the field. Exclusion: none. | LAPSS                      | Monthly paramedic education based on Brain Attack Coalition and American Stroke Association. |

ACLS: Advanced Cardiac Life Support; CPSS: Cincinnati Prehospital Stroke Scale; CT: Computerised tomography; DVD: Digital Versatile Disc; ED: Emergency Department; EEG: Electroencephalogram; EMD: Emergency Medical Dispatcher; EMS: Emergency Medical Service; EMT: Emergency Medical Technician; FAST: Face Arm Speech Time; FASTER: Face, Arm, Speech, Time, Emergency Response; GCS: Glasgow Coma Scale; ICD: International Classification of Diseases; ICH: Intracerebral Haemorrhage; IV: Intravenous; KPSS: Kurashiki Prehospital Stroke Scale; LAPSS: Los Angeles Prehospital Stroke Scale; MASS: Melbourne Ambulance Stroke Screen; MedPACS: Medic Prehospital Assessment for Code Stroke; MRA: Magnetic Resonance Angiography; MRI: Magnetic Resonance Imaging; NIHSS: National Institute of Health Stroke Score; OPSS: Ontario Prehospital Stroke Scale; PreHAST: PreHospital Ambulance Stroke Test; ROSIER: Recognition of Stroke in the Emergency Room; TIA: Transient Ischemic Attack; tPA: Tissue plasminogen activator.
### TABLE 2: Characteristics of prehospital stroke recognition scales

| Assessment                  | FAST | CPSS | OPSS | KPSS | ROSIER | MASS | MedPACS | LAPSS | PreHAST | FASTER | BEFAST |
|-----------------------------|------|------|------|------|--------|------|---------|-------|---------|--------|--------|
| Number of physical examination items | 3    | 3    | 4    | 5    | 5      | 4    | 5       | 3     | 8       | 5      | 5      |
| Facial droop                | Yes  | Yes  | Yes  | Yes  | Yes    | Yes  | Yes     | Yes   | Yes     | Yes    | Yes    |
| Arm weakness/drift          | Yes  | Yes  | Yes  | Yes  | Yes    | Yes  | Yes     | Yes   | Yes     | Yes    | Yes    |
| Leg weakness/drift          | Yes  | Yes  | Yes  | Yes  | Yes    | Yes  | Yes     | Yes   | Yes     | Yes    | Yes    |
| Hand grip strength          |      | Yes  | Yes  |      |        |      |         |       |         |        |        |
| Stability                   |      |      |      |      |        |      |         |       |         |        | Yes    |
| Speech difficulty           | Yes  | Yes  | Yes  | Yes  | Yes    | Yes  | Yes     | Yes   | Yes     | Yes    | Yes    |
| Eye position, gaze preference|      | Yes  | Yes  |      |        |      |         |       |         |        | Yes    |
| Visual field                |      | Yes  | Yes  | Yes  | Yes    | Yes  | Yes     |       |         |        |        |
| Eye diplopia                |      |      |      |      |        |      |         |       |         |        | Yes    |
| Sensory (pain)              |      |      |      |      |        |      |         |       |         |        |        |
| Balance coordination        |      |      |      |      |        |      |         |       |         |        | Yes    |
| Command, verbal instruction |      |      |      |      |        |      |         |       |         |        | Yes    |
| Consciousness disturbance   | Yes  |      |      |      |        |      |         |       |         |        |        |
| Level of consciousness      |      |      |      |      |        |      |         |       |         |        |        |
| Score range                 | 0-3  | 0-3  | 0-4  | 0-13 | -2 to 5 | 0-4 | 0-5     | 0-3   | 0-19    | 0-5    | 0-5    |
| Eligibility criteria        | Yes² | Yes³ | Yes⁴ | Yes⁵ | Yes⁶   | Yes⁷ | Yes⁸    | Yes⁹  | Yes⁶   | Yes⁹   |        |
| Blood glucose measurement   | Yes  | Yes  | Yes  | Yes  | Yes    | Yes  | Yes     | Yes   | Yes     |        |        |

**BEFAST**: Balance Eyes Face Arm Speech Time on call; **CPSS**: Cincinnati Prehospital Stroke Scale; **FAST**: Face Arm Speech Time; **FASTER**: Face, Arm, Speech, Time, Emergency Response; **KPSS**: Kurashiki Prehospital Stroke Scale; **LAPSS**: Los Angeles Prehospital Stroke Scale; **MASS**: Melbourne Ambulance Stroke Screen; **MedPACS**: Medic Prehospital Assessment for Code Stroke; **OPSS**: Ontario Prehospital Stroke Scale; **PreHAST**: PreHospital Ambulance Stroke Test; **ROSIER**: Recognition of Stroke in the Emergency Room.

1. Verbal instruction and sensory. Close your eyes! Grip your hand! (n-paretic side); 2. GCS < 7 or suspected head injury exclusion original paper; 3. Seizure at onset, can be transported to arrive within two hours of onset, time since symptom onset < 2 hours, GCS < 10, blood glucose > 4 mmol/L, symptoms of the stroke have resolved; 4. Blood glucose > 3.5 mmol/L, history of seizure; 5. History of seizure, time since symptom onset < 24 hours, at baseline, patient is not wheelchair bound or bedridden, blood glucose 2.8 to 22.2 mmol/L; 6. History of seizure, time since symptom onset < 24 hours, at baseline, patient is not wheelchair bound or bedridden, blood glucose 3.3 to 22.2 mmol/L; 7. History of seizure, at baseline, patient is not wheelchair bound or bedridden, blood glucose 2.8 to 22.2 mmol/L, age limit = 40 years; 8. Age > 18 years, intended for use, only in conscious people, i.e. alert or aroused by stimulation; 9. Time of onset less than 2 hours, blood glucose measurement inside the range of 4-17 mmol/L.

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**Risk of bias within studies and certainty of the evidence**

An overview of the assessment of the overall certainty of evidence, using ROBINS-I assessment tool for non-randomized studies of interventions studies and QUADAS-2 for diagnostic studies is provided in Tables 3, 4 respectively. Overall, the certainty of evidence was moderate to very low across all outcomes, primarily due to risk of bias, indirectness and imprecision. A detailed overview of GRADE assessments per outcome can be found in Appendix C.
| Domain | Confounding | Selection | Classification of Intervention | Deviation from intended intervention | Missing data | Outcomes | Selective reporting | Overall |
|--------|-------------|-----------|---------------------------------|--------------------------------------|--------------|----------|---------------------|---------|
| Chenkin et al. (2009) [29] | Serious | Low | Low | Serious | Serious | Low | Low | Very serious |
| Harbison et al. (2003) [33] | Information | Low | Serious | Low | Low | Low | Low | Very serious |
| Iguchi et al. (2011) | Low | Serious | Low | Low | Serious | Moderate | Low | Very serious |
| Wojner-Alexandrov et al. (2005) [24] | Low | Serious | Low | Low | Low | Low | Low | Serious |
| O’Brien et al. (2012) | Serious | Serious | Low | Low | Serious | Moderate | Low | Very serious |
| Wall et al. (2008) [23] | Low | Low | Low | Low | Low | Low | Low | Low |

**TABLE 3: Risk of bias in non-randomized studies of interventions (ROBINS-I)**

| Study (Author, year) | Risk of bias | Applicability concerns |
|----------------------|--------------|------------------------|
| Study (Author, year) | Patient selection | Index test | Reference standard | Patient selection | Index test | Reference standard |
| Andsberg et al. (2017) [13] | Low | Low | Low | Low | Low | Low | Low |
| Asimos et al. (2014) [26] | High | Low | High | Low | Low | Low | Low |
| Bergs et al. (2010) [14] | High | Low | Unclear | Unclear | Low | Low | Low |
| Bray et al. (2005) [15] | High | Low | Unclear | Unclear | Low | Low | Low |
| Berglund et al. (2014) [27] | Low | Low | Low | Low | Low | Low | Low |
| Bray et al. (2010) [28] | High | Low | Unclear | Unclear | Low | Low | Low |
| Chen et al. (2013) [16] | High | Low | Low | Unclear | Unclear | Low | Low |
| Chenkin et al. (2009) [29] | High | Low | Unclear | Unclear | Low | Low | Low |
| English et al. (2018) [30] | High | Low | Unclear | Unclear | Low | Low | Low |
| Fothergill et al. (2013) [17] | High | Low | Unclear | Low | Low | Low | Low |
| Frendl et al. (2009) [31] | High | Low | Unclear | Unclear | Low | Low | Low |
| Greenberg et al. (2017) [32] | Low | Low | Low | High | Low | Low | Low |
| Kothari et al. (1999) [25] | Unclear | Low | Low | Low | Low | Low | Low |
| Kidwell et al. (2000) [18] | Low | Low | Low | Unclear | Low | Low | Low |
| Kim et al. (2017) [19] | High | Low | Unclear | Unclear | Low | Low | Low |
| Pickham et al. (2019) [21] | High | Low | High | Low | Low | Low | Low |
| Ramanujam et al. (2008) [35] | High | Low | Unclear | Unclear | Low | Low | Low |
| Studnek et al. (2013) [36] | High | Low | Unclear | Unclear | Low | Low | Low |
| Vanni et al. (2011) [22] | Low | Low | Low | Low | Low | Low | High |

**TABLE 4: Certainty assessment of diagnostic accuracy studies (QUADAS 2)**

Study findings on stroke assessment scale effectiveness
For the critical outcome "time to treatment", we identified four observational studies \[20, 24, 29, 34\] evaluating four different stroke scales (KPSS, LAPSS, OPSS, FASTER). For the KPSS, one retrospective observational study \[34\], enrolling 430 participants with suspected acute stroke in the prehospital setting, showed an association between the use of KPSS and an increase in the number of patients with a time from symptom onset to hospital arrival was within 3 hours. Of patients who had the KPSS applied, 161/256 (62.9%) arrived within 3 hours compared with 91/174 (52.3%) who did not have the scale applied (RR 1.2; 95% CI [1.01 - 1.43]; p = 0.034: very low certainty evidence). The same study showed significantly shorter elapsed time from symptom onset to hospital admission with the use of KPSS (mean time 2.1 hours; interquartile range [1.0 - 6.2]), compared with no KPSS use (mean time 2.7 hours; interquartile range [1.2 - 9.7]; p = 0.024: very low certainty evidence). For the LAPSS, one observational study \[20\], including 1518 prehospital participants with suspected acute stroke, showed an association between the use of the LAPSS and an increased time from symptom onset to emergency department arrival (MD 132.00 min; 95% CI [14.68 - 249.32]; p = 0.097; very low certainty evidence). The same study did not find a significant benefit associated between use of LAPSS and the proportion of patients admitted within 120 min (RR 1.07; 95% CI [0.96 - 1.19]; p = 0.215; very low certainty evidence). For OPSS, one observational study \[29\], enrolling 861 prehospital participants with acute suspected stroke, showed an association between use of the OPSS and increased proportion of patients with a time from symptom onset to hospital arrival within 5 hours when using the OPSS, compared with not using the OPSS (RR 1.45; 95% CI [1.12 - 1.82]; p = 0.004; very low certainty evidence). For FASTER, one observational study \[20\], enrolling 115 prehospital participants, showed an association between use of FASTER and a shortened time from symptom onset to treatment with tissue Plasminogen Activator (tPA) (MD -52 min; 95% CI [-53 to -11]; p = 0.005; very low certainty of evidence).

Furthermore, this study showed an association between the use of FASTER and a shorter door to CT time for patients receiving tPA (MD -30 min; 95% CI [-49 to -11]) p = 0.004, very low certainty of evidence), and a shorter "door to needle" time for patients receiving tPA (MD -46 min; 95% CI [-71 to -21]) p = 0.001, very low certainty of evidence). Among patients receiving tPA, no significant differences were found between the groups with or without FASTER applied for time from symptom onset to hospital arrival (MD, 17 min; 95% CI [-7 to 41]; p = 0.180, very low certainty of evidence). We did not identify any comparative studies evaluating the other scales (FAST, ROSIER, MASS, CPSS, MedPACS and PreHAST) for the critical outcome "time to treatment".

For the important outcome "recognition of stroke" (outcome defined as definitive stroke diagnosis or therapy administration), we identified five observational studies \[20, 24, 29, 35, 34\] evaluating five different stroke scales (FAST, KPSS, FASTER, OPSS, LAPSS). For the FAST scale, one observational study \[35\], enrolling 356 prehospital participants with suspected acute stroke, showed an association with use of FAST and an increased proportion of patients with confirmed stroke or TIA admitted within 5 hours following symptom onset (RR 3.3; 95% CI [2.29 - 4.75]; p < 0.00001, low certainty evidence). For KPSS, one observational study \[34\], enrolling 430 prehospital participants with suspected acute stroke, showed no difference between use and non-use of KPSS for the proportion of patients who were diagnosed with stroke and received thrombolytic therapy (RR 0.95; 95% CI [0.59 - 1.53]; p = 0.838, low certainty evidence). For LAPSS, one observational study \[20\], enrolling 1518 prehospital participants, showed an association with the use of LAPSS by paramedics and an increased proportion of correct initial diagnoses of stroke as confirmed by a neurologist (RR 1.29; 95% CI [1.18 - 1.42]; p < 0.00001, moderate certainty evidence). However, no association was found with the use of the LAPSS and the proportion of patients treated with intravenous tPA among confirmed stroke cases (RR 1.15; 95% CI [0.71 - 1.80]; p = 0.601, moderate certainty evidence). For OPSS, one observational study \[29\], enrolling 861 prehospital participants, showed no association between the use of OPSS and the rate of recognition of ischemic stroke (RR 1.11; 95% CI [0.96 - 1.28]; p = 0.157, low certainty evidence), but did show an association between the use of OPSS and an increased rate of thrombolytic therapy in ischemic stroke cases (RR 1.72; 95% CI [1.03 - 2.88]; p = 0.037, low certainty evidence). For FASTER, one observational study \[20\], including 182 participants, showed an association between the use of FASTER and an increased proportion of stroke patients who received thrombolytic therapy (RR 2.56; 95% CI [1.02 - 6.45]; p = 0.045, very low certainty evidence).

For the important outcome of increased public/layperson recognition of stroke signs, one observational study \[25\], enrolling 72 participants (members of the public), was included. This study reported that immediately after training compared with pre-training, there was a significant increase in the percentage of participants who recognized facial droop, arm weakness and slurred speech as signs of stroke (68/72 [94.4%]) compared with 55/72 (76.4%); RR 1.24; 95% CI [1.07 - 1.42]; p = 0.003, moderate certainty evidence). Of the 65 participants who were retested three months after the training, compared with pre-training, 100% remembered slurred speech and facial drooping as stroke symptoms; 98.5% remembered arm weakness or numbness, showing no significant change from the immediate post-training test (moderate certainty of evidence).

We did not identify any comparative studies evaluating stroke recognition for the outcomes of "favorable neurologic status" or "survival with favorable neurologic outcome".

For the outcome of recognition of stroke (diagnostic studies, outcome defined as correct stroke diagnosis), we identified 19 observational studies \[13-19, 21, 22, 25-32, 35, 36\] including a total of 8153 participants, evaluating nine different screening tools (FAST, LAPSS, OPSS, CPSS, ROSIER, MASS, BEFAST, Med-PACS, Pre-HAST) (Table 3). The reported prevalence, sensitivity, specificity, positive and negative likelihood ratio for each scale are reported in Table 5. Four scales, FAST (Figure 2A), LAPSS (Figure 2B), CPSS (Figure 2C) and MASS (Figure 2D), were assessed by more than one study. The diagnostic accuracy of the FAST scale was assessed by very low certainty evidence from four observational prospective studies \[14, 17, 21, 27\], including 1585 participants suspected of having a stroke. The summary estimate for sensitivity was 0.86, 95% CI [0.69 - 0.94] and the summary estimate for specificity was 0.38, 95% CI [0.16 - 0.66]. The diagnostic accuracy of the
LAPSS was assessed by low certainty evidence from four prospective observational studies [14-16, 18] and one retrospective study [26]. The studies included a total of 2692 participants suspected of having a stroke. The summary estimate for sensitivity was 0.78, 95% CI [0.75-0.81] and the summary estimated diagnostic specificity was 0.86, 95% CI [0.67-0.95]. The diagnostic accuracy of the CPSS was assessed by very low certainty evidence from two prospective observational studies [14, 15, 19, 22, 25, 28] and six retrospective observational studies [26, 30-32, 35, 36]. The studies included a total of 4842 participants suspected of having a stroke. The summary estimate for sensitivity was 0.81, 95% CI [0.70-0.89] and the summary estimate for specificity was 0.55, 95% CI [0.39-0.69]. Two additional studies were identified [22, 32], but these provided incomplete data and could not be included in the meta-analysis. The diagnostic accuracy of the MASS was assessed by low certainty evidence from four prospective observational studies [26, 30, 31, 35].

| Stroke Scale | Study (Author, year) | Sample size | Stroke prevalence (%)(Number/total, %) | Sensitivity (95% CI) | Specificity (95% CI) | Positive likelihood-ratio (95% CI) | Negative likelihood-ratio (95% CI) |
|--------------|----------------------|-------------|----------------------------------------|----------------------|----------------------|------------------------------------|-----------------------------------|
| FAST         | Bergs et al. (2010)  | 31          | 19/31 (61%)                            | 0.95 [0.74-1.00]     | 0.33 [0.10-0.65]     | 1.42 [0.94-2.15]                  | 0.16 [0.02-1.25]                  |
|              | Fothergill et al. (2013) | 295         | 177/295 (60%)                        | 0.97 [0.93-0.99]     | 0.13 [0.07-0.20]     | 1.11 [1.03-1.19]                  | 0.27 [0.11-0.67]                  |
|              | Benglund et al. (2014) | 900         | 472/900 (52%)                        | 0.64 [0.59-0.68]     | 0.75 [0.71-0.79]     | 2.55 [2.14-3.05]                  | 0.48 [0.42-0.55]                  |
|              | Pickham et al. (2019) | 359         | 159/359 (44%)                         | 0.76 [0.69-0.82]     | 0.46 [0.38-0.53]     | 1.40 [1.20-1.63]                  | 0.53 [0.38-0.72]                  |
| CPSS         | Asimos et al. (2014)  | 1217        | 663/1217 (54%)                       | 0.80 [0.77-0.83]     | 0.48 [0.44-0.52]     | 1.55 [1.42-1.70]                  | 0.41 [0.35-0.48]                  |
|              | Bergs et al. (2010)  | 31          | 19/31 (61%)                            | 0.95 [0.74-1.00]     | 0.33 [0.10-0.65]     | 1.42 [0.94-2.15]                  | 0.16 [0.02-1.25]                  |
|              | Bray et al. (2010)   | 850         | 199/850 (23%)                         | 0.88 [0.83-0.93]     | 0.79 [0.75-0.82]     | 4.17 [3.57-4.88]                  | 0.15 [0.10-0.22]                  |
|              | Bray et al. (2005)   | 100         | 73/100 (73%)                          | 0.95 [0.87-0.98]     | 0.56 [0.35-0.75]     | 2.13 [1.39-3.25]                  | 0.10 [0.04-0.27]                  |
|              | Frendl et al. (2009) | 154         | 61/154 (40%)                          | 0.70 [0.57-0.81]     | 0.52 [0.41-0.62]     | 1.46 [1.12-1.90]                  | 0.57 [0.37-0.88]                  |
|              | Kohari et al. (1989) | 171         | 49/171 (29%)                          | 0.59 [0.52-0.66]     | 0.88 [0.85-0.91]     | 4.88 [3.74-6.37]                  | 0.47 [0.40-0.55]                  |
|              | Ramanujam et al. (2008) | 1045      | 440/1045 (42%)                        | 0.44 [0.39-0.49]     | 0.53 [0.49-0.57]     | 0.93 [0.82-1.07]                  | 1.06 [0.95-1.18]                  |
|              | English et al. (2018) | 130        | 96/130 (74%)                          | 0.75 [0.65-0.83]     | 0.21 [0.09-0.38]     | 0.94 [0.77-1.16]                  | 1.21 [0.58-2.56]                  |
|              | Kim et al. (2017)    | 268         | 152/268 (57%)                         | 0.93 [0.88-0.97]     | 0.73 [0.64-0.81]     | 3.50 [2.58-4.74]                  | 0.09 [0.07-0.17]                  |
|              | Studnek et al. (2013) | 416        | 186/416 (45%)                         | 0.79 [0.72-0.85]     | 0.24 [0.19-0.30]     | 1.04 [0.94-1.15]                  | 0.88 [0.61-1.26]                  |
|              | Vanni et al. (2011)  | 155         | 87/155 (56%)                          | Not estimated        | Not estimated        | Not estimated                     | Not estimated                    |
|              | Greenberg et al. (2017)  | 305        | 79 (26%)                              | Not estimated        | Not estimated        | Not estimated                     | Not estimated                    |
| LAPSS        | Asimos et al. (2014)  | 1225        | 805/1225 (66%)                        | 0.74 [0.71-0.77]     | 0.48 [0.43-0.53]     | 1.42 [1.28-1.57]                  | 0.54 [0.47-0.63]                  |
|              | Bergs et al. (2010)  | 31          | 19/31 (61%)                            | 0.74 [0.49-0.91]     | 0.83 [0.52-0.98]     | 4.42 [1.21-16.12]                 | 0.32 [0.14-0.70]                  |
|              | Bray et al. (2005)   | 100         | 73/100 (73%)                          | 0.78 [0.67-0.87]     | 0.85 [0.66-0.96]     | 5.27 [2.12-13.13]                 | 0.26 [0.16-0.41]                  |
|              | Chen et al. (2013)   | 1130        | 997/1130 (88%)                        | 0.78 [0.76-0.81]     | 0.90 [0.84-0.95]     | 8.02 [4.78-13.46]                 | 0.24 [0.21-0.27]                  |
| Study          | Sample Size | Sensitivity (95% CI) | Specificity (95% CI) | Positive Predictive Value (95% CI) | Negative Predictive Value (95% CI) |
|---------------|-------------|----------------------|----------------------|-----------------------------------|-----------------------------------|
| Kidwell et al. (2000) | 34/206 (16%) | 0.91 [0.76-0.98] | 0.97 [0.93-0.99] | 31.36 [13.14-74.87] | 0.09 [0.03-0.27] |
| Bergs et al. (2010) | 19/31 (61%) | 0.74 [0.49-0.91] | 0.67 [0.35-0.90] | 2.21 [0.95-5.14] | 0.39 [0.17-0.93] |
| Bray et al. (2010) | 199/850 (23.4%) | 0.83 [0.78-0.88] | 0.86 [0.83-0.88] | 5.90 [4.84-7.20] | 0.19 [0.14-0.26] |
| Bray et al. (2005) | 73/100 (73%) | 0.90 [0.81-0.96] | 0.74 [0.54-0.89] | 3.49 [1.84-6.63] | 0.13 [0.06-0.27] |
| Studnek et al. (2013) | 186/416 (45%) | 0.74 [0.67-0.80] | 0.33 [0.27-0.39] | 1.10 [0.97-1.25] | 0.79 [0.58-1.08] |
| Chenkin et al. (2009) | 214/554 (39%) | 0.87 [0.82-0.92] | 0.59 [0.54-0.65] | 2.15 [1.87-2.47] | 0.21 [0.15-0.31] |
| Fothergill et al. (2013) | 177/295 (60%) | 0.97 [0.93-0.99] | 0.18 [0.11-0.26] | 1.18 [1.08-1.28] | 0.19 [0.08-0.46] |
| Andsberg et al. (2017) | 26/69 (38%) | 1.00 [0.87-1.00] | 0.40 [0.25-0.56] | 1.65 [1.30-2.11] | 0.00 |
| Pickham et al. (2019) | 159/359 (44%) | 0.91 [0.86-0.95] | 0.26 [0.20-0.33] | 1.23 [1.12-1.36] | 0.34 [0.19-0.59] |

**TABLE 5: Operating characteristics of prehospital stroke scales by included study**

FAST: Face Arm Speech Time; CPSS: Cincinnati Prehospital Stroke Scale; LAPSS: Los Angeles Prehospital Stroke Scale; MASS: Melbourne Ambulance Stroke Screen; Med PACS: Medic Prehospital Assessment for Code Stroke; OPSS: Ontario PreHospital Stroke Scale; ROSIER: Recognition of Stroke in the Emergency Room; PreHAST: PreHospital Ambulance Stroke Test; BEFAST: Balance Eyes Face Arm Speech Time on call.
Studies of stroke assessment scales can be divided into subgroups based on whether the scale includes blood glucose measurement or not. In the nine diagnostic studies that used stroke scales with blood glucose measurement (LAPSS, OPSS, ROSIER, MASS, Med-PACS) \([14-18, 26, 28, 29, 36]\), the reported sensitivities ranged from 0.74 to 0.97, compared with 0.80 to 1.00 in the 14 studies of stroke scales that did not include blood glucose measurement (FAST, CPSS, Pre-HAST, BEFAST) \([13-15, 17, 19, 21, 25-28, 30, 31, 35, 36]\). The reported specificities from studies with stroke scales including blood glucose measurement (LAPSS, OPSS, ROSIER, MASS, Med-PACS) ranged between 0.18 and 0.86 compared with 0.26 to 0.55 in the studies that used scales without blood glucose measurement (PreHAST, FAST, CPSS, BEFAST). The comparison of Summary Receiver Operating Characteristics (SROC) curve between stroke scales with blood glucose measurement and stroke scales without blood glucose measurement is presented in Figure 3. The first comparison covers all studies (Figure 3A, 3B); the second covers only the scores assessed by more than one study (Figure 3C, 3D).
FIGURE 3: Summary receiver operating characteristics (SROC) plot of strokes scales with and without glucose measurement

A- SROC of stroke scales with glucose measurement; B- SROC of stroke scales without glucose measurement; C- SROC of stroke scales with more than one study per scale with glucose measurement; D- SROC of stroke scales with more than one study per scale without glucose measurement.

Discussion

We identified and systematically reviewed studies of accuracy for prehospital stroke recognition tools that are applied in the prehospital setting and potentially suitable for use by first aid providers. We consider an ideal stroke assessment tool for first aid to be one that is easily understood and remembered, has a high sensitivity for detecting stroke and can be completed in minimal time. Because the home use of blood glucose measurement devices is increasingly common in populations at risk for acute stroke, we included prehospital stroke scales that incorporate blood glucose measurements but evaluated them separately for accuracy. In this systematic review, three of the four included scales (KPSS, FASTER and OPSS) showed an association between prehospital use and a decreased time from stroke onset to treatment [20, 29, 34]. Unfortunately, it was not possible to perform a meta-analysis for this outcome due to the limited number of studies.

In terms of definitive stroke diagnosis or therapy administration, using a stroke recognition scale in the prehospital setting does not seem to increase the proportion of patients with confirmed stroke diagnosis. However, patients with confirmed stroke were promptly admitted to a hospital and received treatment more quickly.

For accuracy of recognition of stroke we pooled the data from the 17 diagnostic studies of FAST, CPSS, LAPSS, and MASS individually to calculate a summary estimated sensitivity and specificity [14-19, 21, 22, 25-28, 30-32, 35, 36]. Other scales that were only assessed by a single study were not included [13, 17, 21, 29, 36]. We considered both the FAST and CPSS to be stroke assessment tools that a first aid provider would find easy to understand, remember and to use. These two stroke scales are supported by multiple studies with a large total number of participants but do not include a blood glucose measurement. For FAST, the sensitivities in four studies ranged from 0.64 to 0.97 [14, 17, 21, 27] with a summary estimated sensitivity of 0.86 [0.69-0.94]. For CPSS, the sensitivity measurements from 10 included studies ranged from 0.44 to...
There are many stroke scales available for use in the prehospital environments and the selection of which scales...interpret the summary estimate result with caution. Studies for patient selection or quality of the reference standard, and most of the studies failed to include all the outcome "time to treatment". Additional articles that were missed during the review process. Finally, the risk of bias is serious or moderate reflects difficulties in correctly identifying observational studies of stroke recognition in adults in a prehospital setting with a large number of participants have been included (FAST, CPSS, LAPSS, MASS). Six scales (FASTER, KPSS, ROSIER, BEFAST, Med-PACS) were only investigated in single studies, including between 250 and 600 participants [13, 17, 20, 21, 29, 34, 56]. The PreHAST scale provided the highest sensitivity (1.00, 95% CI [0.87-1.00]), but was only evaluated in a single study, with 69 participants [13]. The prevalence of stroke/TIA ranged from 23% [28] to 88% [16] (Table 5), reflecting differences in population and patient selection that may affect sensitivity and specificity estimates. Second, the accuracy of the scales for identifying people with stroke/TIA may also be affected by confounders such as differences in age, sex, and the rate of stroke diagnosis. wolves [16, 18]. Prehospital stroke recognition scales should not be interpreted as confirmatory diagnostic tests but only as a screening test. Most of the studies only assessed the outcomes of true positive patients, however it would be of value to know the impact of the scale on those who were false negatives.

Two stroke assessment scales that include blood glucose measurement in their eligibility criteria (MASS and LAPSS) were evaluated by multiple studies and included 981 patients for MASS and 2692 patients for LAPSS (Table 5). We found these scales had similar sensitivities for stroke identification as for scales without blood glucose measurement, but increased specificities (Figure 3C, 3D). We recognize that many first aid providers may not have access or the skills to use a properly calibrated glucometer. Local guidelines would need to determine the benefit of increased specificity of stroke scales that include glucose measurement compared with using simpler stroke scales that do not require glucose measurement.

Three systematic reviews analyzed stroke recognition instruments in the prehospital setting [37-39]. Brandler et al. in 2014 included studies in which the scales were used by paramedics or emergency medical technicians (EMTs) and included scales requiring blood glucose measurement [37]. The authors concluded that LAPSS performed more consistently and that LAPSS and CPSS had similar diagnostic capabilities. Our systematic review includes all of the studies evaluated by Brandler et al. and adds new data from 16 more publications. Additionally, we report diagnostic accuracy of scales that require blood glucose measurement separately from those without glucose measurement, to help identify appropriate scales for use by first aid providers. A systematic review by Rudd et al. in 2016 included all studies in which the scales were administered face-to-face by any prehospital or hospital clinician to identify adults suspected of stroke [38]. Eleven studies included in this systematic review were also included in our review, but 10 studies did not meet our inclusion criteria (seven papers and three abstracts). The authors concluded that available data do not allow a strong recommendation to be made about the superiority of a particular stroke recognition scale evaluated. Zhelev et al. in a Cochrane review in 2019 analyzed prehospital stroke scales as screening tools for early identification of stroke and transient ischemic attack [39]. They included in a "prehospital setting subgroup" all studies where the scale had been used in the prehospital setting regardless of the background and training of the person performing the assessment, and only evaluated diagnostic accuracy. The author concluded, "in the field, CPSS had consistently the highest sensitivity but was less specific than most of the scales". In our systematic review, we have focused on the scales that can potentially be used by trained first aid providers or lay persons in a prehospital setting. We attribute our inclusion and exclusion criteria to any differences in our results. Lastly, our systematic review is not limited to a diagnostic accuracy review. We also evaluated the influence of stroke scale use on the time to treatment and the rate of stroke diagnosis.

Our review has some limitations. First, only four stroke scales were investigated by more than a single study, for which a large number of participants have been included (FAST, CPSS, LAPSS, MASS). Six scales (FASTER, OPSS, KPSS, ROSIER, BEFAST, Med-PACS) were only investigated in single studies, including between 250 and 600 participants [13, 17, 20, 21, 29, 34, 56]. The PreHAST scale provided the highest sensitivity (1.00, 95% CI [0.87-1.00]), but was only evaluated in a single study, with 69 participants [13]. The prevalence of stroke/TIA ranged from 23% [28] to 88% [16] (Table 5), reflecting differences in population and patient selection that may affect sensitivity and specificity estimates. Second, the accuracy of the scales for identifying people with stroke/TIA may also be affected by confounders such as differences in age, sex, and the proportion of patients with ischemic stroke, hemorrhagic stroke or TIA (Table 1), the difference in inclusion criteria between studies and in the provider applying the scale. In most studies, the stroke scale assessment was performed by paramedics or nurses, making the evidence indirect for the first aid setting. However, Liferidge et al. found that lay providers were able to use the CPSS to detect stroke in volunteers with simulated stroke with 94.3% sensitivity (95% CI [86.6-100.0]) and 82.93% specificity (95% CI [70.4-95.3]) [40]. Third, the overall Kappa for the review of titles/abstracts was moderate (Kappa = 0.44). This reflects difficulties in correctly identifying observational studies of stroke recognition in adults in a prehospital setting. However, based on a subsequent review of reference lists, we did not identify any additional articles that were missed during the review process. Finally, the risk of bias is serious or moderate in four of six studies due to possible confounding, missing data and the different time interval definitions for the outcome "time to treatment" [29, 33, 34]. Risk of bias is high or unclear in most of the diagnostic studies for patient selection or quality of the reference standard, and most of the studies failed to include all eligible consecutive participants. The methodology used by the studies is often different, measurement of the time to treatment is not the same, and the method and the length of training used to teach the score varied between studies. There is a high level of between-study heterogeneity, and therefore we must interpret the summary estimate result with caution.

Conclusions

The use of stroke recognition scales in the prehospital setting should be encouraged. They assist in the detection of the presence of stroke and reduce the time from symptom onset to definitive treatment.

There are many stroke scales available for use in the prehospital environments and the selection of which...
scale to use remains complex. This review has shown that the use of the FAST and OPSS stroke recognition scales increases the proportion of stroke patients who receive therapy in the first hours following the onset of stroke. Furthermore, FAST and MASS are the scales with the highest sensitivity, while CPSS is the scale with the highest specificity. When blood glucose measurement is possible in the prehospital setting, LAPSS and MASS are scales with sensitivities similar to that for CPSS and FAST but provide greater specificity for the recognition of stroke.

**Appendices**

**APPENDIX A: Full search strategy for each database**

*2015 ILCOR FATF CoSTR Systematic Review on Stroke Recognition*

The results of the search strategy for the 2015 ILCOR First Aid Task Force (FATF) systematic review on stroke recognition are presented in Table 6.

| Databases Searched                          | Date of Search      | Number of Articles |
|---------------------------------------------|---------------------|--------------------|
| All Medline <1946 - 2019                    | September 26, 2019  | 2098               |
| All Embase <1947 - 2019                     | September 26, 2019  | 1316               |
| Cochrane Trials only <1947 - 2019          | September 28, 2019  | 30                 |
| Total (<1947 – 2019)                       |                     | 3759               |

**TABLE 6: Results of the search strategy, 2015 ILCOR FATF systematic review on stroke recognition**

After duplicates were removed, title and abstract were screened, full-text articles were independently assessed and disagreements resolved through discussion, 24 articles were included in the 2015 systematic review.

*Rerun Strategy from January 2014 to September 2019*

The rerun strategy from January 2014 to September 2019 in three databases (MEDLINE, EMBASE and COCHRANE) and results are presented in Tables 7, 8 (Date of search: 26/09/2019).

| #    | Searches                                                                 | Number of Articles |
|------|--------------------------------------------------------------------------|--------------------|
| 1    | Stroke[MeSH Terms]                                                      | 125,634            |
| 2    | acute[Title/Abstract]                                                   | 1,133,443          |
| 3    | #1 AND #2                                                               | 30,212             |
| 4    | acute stroke*[Title/Abstract]                                           | 14,610             |
| 5    | acute cerebrovascular accident*[Title/Abstract]                         | 200                |
| 6    | #3 OR #4 OR #5                                                          | 34,856             |
| 7    | scale*[Title/Abstract]                                                  | 768,820            |
| 8    | score*[Title/Abstract]                                                  | 856,723            |
| 9    | scoring[Title/Abstract]                                                 | 75,964             |
| 10   | OR #7 OR #9                                                             | 1,445,022          |
| 11   | Time-to-Treatment[MeSH Terms]                                           | 5308               |
| 12   | ©[MeSH Terms]                                                            | 1,162,338          |
| 13   | time-to-treatment[Title/Abstract]                                       | 3325               |
| 14   | recogn*[Title/Abstract]                                                 | 723,108            |
| 15   | cognitive knowledge*[Title/Abstract]                                    | 222                |
| 16   | neurologic outcome*[Title/Abstract]                                     | 3587               |
17 neurologic status[Title/Abstract] 1837
18 OR #11-#17 1,875,735
19 #6 AND #10 AND #18 2185
20 animals[mh] NOT humans[mh] 4,622,905
21 *letter*[pt] OR *comment*[pt] OR *editorial*[pt] OR Case Reports[ptyp] 3,603,162
22 #19 NOT #20 NOT #21 2098
23 *2014/01/01*[PDAT] : *2019/09/26*[PDAT] 6,592,744
24 #22 AND #23 1042
Database(s): EMBASE (R), via Embase.com
1 'cerebrovascular accident'/de 308,474
2 acute:ab,ti 1,585,164
3 1 AND 2 66,054
4 [acute near/3 stroke*]:ab,ti 54,551
5 'acute cerebrovascular accident':ab,ti 230
6 'acute cerebrovascular accidents':ab,ti 138
7 #3 AND #4 AND #5 AND #6 86,881
8 'scoring system'/de 246,463
9 'rating scale'/de 108,517
10 scale*:ab,ti 1,008,513
11 score*:ab,ti 1,340,709
12 scoring:ab,ti 117,138
13 OR #6-#12 2,138,593
14 'time to treatment'/de 14,751
15 'time factors'/de 29,856
16 'time to treatment':ab,ti 6073
17 recogn*:ab,ti 914,845
18 'cognitive knowledge':ab,ti 279
19 'neurologic outcome':ab,ti 3760
20 'neurologic outcomes':ab,ti 1836
21 'neurologic status':ab,ti 2500
22 OR #14-#21 968,595
23 #7 AND #13 AND #22 1477
24 animal'/exp NOT 'human'/exp 5,326,301
25 #23 NOT #24 1460
26 [editorial]/lim OR [letter]/lim OR 'case report'/de 4,003,436
27 #25 NOT #26 1408
28 #27 AND [embase]/lim 1316
29 #28 AND (2014-2019)/py 775
Database(s): The Cochrane Library(R)
1 [mh Stroke] 8451
2 acute:ab,ti 132,671
3 #1 AND #2 2412
### TABLE 7: Rerun strategy from January 2014 to September 2019 in MEDLINE, EMBASE and COCHRANE (date of search: 26/09/2019)

| Databases Searched | Date of Search | Number of Results |
|--------------------|----------------|-------------------|
| All Medline <2014 - 2019> | September 26, 2019 | 1042 |
| All Embase <2014 - 2019> | September 26, 2019 | 775 |
| Cochrane Trials only <2014 - 2019> | September 28, 2019 | 196 |
| Total (<2014 - 2019) | | 2013 |
| Total <2014 - 2019 (after deduplication) | | 1651 |
| Total after title and abstract screen | | 40 |
| Total after full text stage | | 4 |

### TABLE 8: Result of the re-run of search strategy from 1 January 2014 to 26 September 2019

Rerun Strategy from September 2019 to May 2020

Results of the search strategy from September 2019 to May 2020 are presented in Tables 9, 10 (date of search 05/20/2020).

| # Searches | Number of Articles |
|------------|--------------------|
| Database: MEDLINE(R), via the PUBMED interface | |
| 1 Stroke[MeSH Terms] | 1982 |
| 2 acute[Title/Abstract] | 670 |
| 3 #1 AND #2 | 670 |
| 4 acute stroke*[Title/Abstract] | 873 |
|   | Term                                                   | Count |
|---|-------------------------------------------------------|-------|
| 5 | acute cerebrovascular accident*[Title/Abstract]       | 4     |
| 6 | #3 OR #4 OR #5                                       | 1351  |
| 7 | scale*[Title/Abstract]                              | 53,910|
| 8 | score*[Title/Abstract]                              | 65,364|
| 9 | scoring*[Title/Abstract]                            | 4852  |
|10 | OR #7-49                                             | 104,908|
|11 | Time-to-Treatment*[MeSH Terms]                      | 342   |
|12 | "Time Factors" [MeSH Terms]                         | 5072  |
|13 | time-to-treatment*[Title/Abstract]                  | 244   |
|14 | recogn*[Title/Abstract]                             | 30,991|
|15 | cognitive knowledge*[Title/Abstract]                | 197   |
|16 | neurologic outcome*[Title/Abstract]                 | 71    |
|17 | neurologic status*[Title/Abstract]                  | 36,660|
|18 | OR #11-17                                           | 65    |
|19 | #6 AND #10 AND #18                                  | 65    |
|20 | animals[mh] NOT humans[mh]                          | 27,043|
|21 | "letter"[pt] OR "comment"[pt] OR "editorial"[pt] OR Case Reports[ptyp] | 88,312|
|22 | #19 NOT #20 NOT #21                                 | 65    |
|23 | "2014/01/01"[PDAT] : "2019/09/26"[PDAT]              | 65    |

Database(s): EMBASE (R), via Embase.com
# TABLE 9: Results of the search strategy from September 2019 to May 2020 (date of search 05/20/2020)
### Databases Searched

| Databases Searched                                      | Date of Search | Number of Articles |
|---------------------------------------------------------|----------------|-------------------|
| All Medline                                             | May 25, 2020, 2019 | 65                |
| All Embase < Sept. 2019 to May 2020>                    | May 25, 2020, 2019 | 94                |
| Cochrane Trials only < Sept. 2019 to May 2020>          | May 25, 2020, 2019 | 22                |
| Total (Sept. 2019 to May 2020)                          |                | 181               |
| Total < Sept. 2019 to May 2020 (after deduplication)    |                | 163               |
| Total after title and abstract screen                   |                | 6                 |
| Total after full text stage                             |                | 0                 |

### TABLE 10: Results of the rerun search strategy from 26 September 2019 to 25 May 2020

**Global Search Strategy from Inception to May 2020**

The results of the global search strategy are presented in Table 11.

| Sources                                                                 | Number of Articles | Number of Articles Selected |
|------------------------------------------------------------------------|--------------------|----------------------------|
| 2015 ILCOR FATF systematic review on stroke recognition                | 24                 | 16                         |
| Other sources                                                          | 8                  | 4                          |
| 2019 rerun search strategy ILCOR FATF                                  | 1651               | 4                          |
| 2020 rerun search strategy ILCOR FATF                                  | 163                | 0                          |
| Total of included studies                                              | 24                 |                            |

### TABLE 11: Result of the global search strategy for stroke recognition

### APPENDIX B: Characteristics of excluded studies

The characteristics of excluded studies are presented in Table 12.

| First Author, Year | Reasons for Exclusion                                      |
|--------------------|------------------------------------------------------------|
| Antonenko, 2014    | Congress presentation, abstract only, wrong population    |
| Atsumi, 2015       | No comparison, effect of a protocol over time             |
| Bergman, 2015      | Congress presentation, abstract only                       |
| Brininger, 2018    | Congress presentation, abstract only                       |
| Bugge, 2019        | Congress presentation, abstract only                       |
| Chen, 2015         | Wrong intervention, wrong population                       |
| Chen, 2016         | Wrong intervention                                         |
| Ciobanu, 2017      | No text found, congress presentation                       |
| Dami, 2017         | Wrong intervention, stroke recognition by dispatchers     |
| Glidden,            |                                                            |
| Year | Study Description |
|------|------------------|
| 2019 | Congress presentation, abstract only, wrong intervention: nursing triage process using the acronym "FLASHED" |
| Gramling, 2014 | Wrong population (children) |
| Gropen, 2019 | Wrong population (large vessel occlusion) |
| Hamm, 2015 | Congress presentation, abstract only |
| He, 2017 | Scale use by GPs |
| Hsieh, 2016 | Wrong scale (assessment of prenotification protocol not only CPSS and they add glycaemia) |
| Huang, 2016 | No specific scale assesses but they assess different various measures taken to reduce delay |
| Jia, 2017 | Wrong intervention, stroke recognition by EMS dispatcher and crew |
| Jain, 2014 | Wrong intervention, scale completed in an Emergency Department |
| Kaps, 2014 | Assessment of the frequency of warning signs in younger patients with stroke with a special regard to FAST |
| Kharinotova, 2018 | Congress presentation, abstract only |
| Kim, 2016 | Congress presentation, abstract only |
| Lee, 2014 | Congress presentation, abstract only, wrong population (in an emergency department) |
| Mao, 2016 | Wrong population (suspected stroke presenting in the emergency department with symptoms or signs within 7 days; Scale completed in an emergency department) |
| Mould-Millman, 2018 | Wrong intervention (assessment of a protocol made by the dispatcher, paramedics and ED) |
| Neville, 2016 | Wrong population (children) |
| Noorian, 2018 | Wrong population (suspicion of stroke with a large vessel occlusion) |
| Ocstema, 2018 | Wrong population (suspicion of stroke limited to posterior circulation stroke) |
| Ocstema, 2015 | Wrong population (limited to ischemic stroke) |
| Paden, 2015 | Congress presentation, abstract only |
| Purrucker, 2017 | Wrong population (suspicion of stroke with a large vessel occlusion) |
| Quenardelle, 2015 | Congress presentation, abstract only |
| Silva, 2015 | Congress presentation, abstract only |
| Taqi, 2015 | Wrong intervention (Large Vessel Occlusion Screening Tool) |
| Whiteley, 2011 | Wrong intervention (scale made in the emergency department) |
| Zaidi, 2017 | Wrong intervention (Large Vessel Occlusion Screening Tool) |
| Zhai, 2017 | Congress presentation, abstract only |
| Zhao, 2018 | Wrong intervention (Large Vessel Occlusion Screening Tool) |
| Zohrevandi, 2015 | Wrong intervention (scale assessed in an Emergency Department) |
| Studies excluded from 2015 CoSTR ILCOR FATF |
| Buck, 2009 | Wrong intervention (emergency medical dispatcher) |
| De Lucas, 2013 | Wrong intervention (emergency medical dispatcher) |
| Jiang, 2014 | Wrong intervention (the original research purpose was to validate the ROSIER score in the emergency room and not in prehospital settings) |
### TABLE 12: Characteristics of excluded studies

| Study            | Exclusion/Population/Intervention                                                                 |
|------------------|--------------------------------------------------------------------------------------------------|
| Kleindorfer, 2007| Exclusion (retrospectively collection of signs by nurses in medical records of all stroke patients) |
| You, 2013        | Wrong population (thrombolytic candidates in acute ischemic stroke only). Exclusion (the aim of this study is to investigate the usefulness of the CPSS to determine stroke severity by comparing CPSS and NIHSS scores in patients who may be candidates for thrombolysis on arrival at the hospital within 6 hours of symptom onset) |
| Naziel, 2008     | Wrong population (the aim of the study is to determine whether LAMS scores can predict the presence of large vessel occlusions in acute cerebral ischemia patients) |
| Nor, 2005        | Wrong intervention (emergency physicians with ROSIER and retrospective calculation based on neurologist-recorded signs for CPSS, LAPSS and FAST) |
| Whiteley, 2011   | Wrong intervention (The stroke scale was completed by emergency physicians)                       |
| Yock-Corrales, 2011| Wrong population and exclusion criteria (scale applied retrospectively to children only with ischemic stroke) |
| Kaps, 2014       | Wrong population (younger people), wrong intervention (retrospective analysis on hospital signs)  |
| Willaert, 2020   | Congress presentation, abstract only                                                              |
| Colton, 2020     | Wrong intervention, wrong population (Intracranial hemorrhage only)                               |
| Car, 2020        | Wrong intervention (emergent large vessel occlusion)                                              |
| Madhok, 2019     | Wrong intervention (no limit to CPSS but a whole protocol before and after the implementation)     |
| Lee, 2020        | Wrong intervention                                                                               |

### APPENDIX C: Evidence profile tables

Evidence Profile Tables for Observational Studies

Evidence profile tables for observational studies are presented in Tables 13-18.
| Certainty Assessment | No. of Patients | Effect | Certainty | Importance |
|----------------------|-----------------|--------|-----------|------------|
| No. of studies       | Study design    | Risk of bias | Inconsistency | Indirectness | Imprecision | Other considerations |
| Rate of patient admitted <3 h with stroke diagnosis | 1 | observational studies | very serious a | not serious | serious b | not serious | none | KPSS | Standard assessment | Relative (95% CI) | Absolute (95% CI) | 105 more per 1 000 (from 5 more to 225 more) | VERY LOW | CRITICAL |
| 1 | observational studies | very serious a | not serious | serious b | not serious | none | 161/256 (62.9%) | 91/174 (52.3%) | RR 1.20 (1.01 to 1.43) | 7 fewer per 1 000 (from 59 fewer to 76 more) | VERY LOW | IMPORTANT |
| No. of patients who received tPA | 1 | observational studies | very serious a | not serious | serious b | not serious | none | KPSS | Standard assessment | Relative (95% CI) | Absolute (95% CI) | 7 fewer per 1 000 (from 59 fewer to 76 more) | VERY LOW | IMPORTANT |
| Onset to admission | 1 | observational studies | very serious a,c | not serious | serious b | not serious | none | 256 | 174 | The mean onset to admission was 0 | MD 0.6 lower (0.83 Lower to 0.37 lower) | VERY LOW | CRITICAL |

**TABLE 13: Evidence profile table for Kurashiki Prehospital Stroke Scale (KPSS)**

CI: Confidence interval; RR: Risk ratio; MD: Mean difference

**Question:** KPSS compared to Standard assessment for Adults with suspected acute stroke

**Bibliography:** Iguchi 2011 [34]

**Explanations:** a- The score was not calculated for 174 patients in the series, small sample size; b- The KPSS is used to identify thrombolytic candidates; c- Selective reported result.
| Study Design | Risk of Bias | Indirectness | Other Considerations | LAPSS Standard Assessment | Relative Risk (95% CI) | Absolute Risk (95% CI) | Certainty | Importance |
|--------------|--------------|--------------|----------------------|--------------------------|------------------------|------------------------|-----------|------------|
| **Rate onset to admission < 2 h** | | | | | | | | | |
| 1 observational studies | serious a | not serious | serious b | not serious | none | 418/674 (62.0%) | 210/362 (58.0%) | RR 1.07 (0.96 to 1.19) | 41 more per 1,000 (from 23 fewer to 110 more) | ⬤◯◯◯ | CRITICAL |
| **Onset to ED Arrival** | | | | | | | | | |
| 1 observational studies | serious a | not serious | serious b | not serious | none | 680 | 359 | MD 132 higher (14.68 higher to 249.32 higher) | ⬤◯◯◯ | CRITICAL |
| **Treatment with IV tPA of confirmed stroke cases** | | | | | | | | | |
| 1 observational studies | serious a | not serious | serious b | not serious | none | 64/533 (12.5%) | 21/198 (10.6%) | RR 1.13 (0.71 to 1.80) | 14 more per 1,000 (from 31 fewer to 85 more) | ⬤◯◯◯ | VERY LOW |
| **Nb of good diagnosis by paramedics at discharge** | | | | | | | | | |
| 1 observational studies | serious a | not serious | serious b | not serious | none | 709/895 (79.2%) | 198/323 (61.3%) | RR 1.29 (1.18 to 1.42) | 178 more per 1,000 (from 110 more to 257 more) | ⬤◯◯◯ | VERY LOW |

**TABLE 14: Evidence profile table for Los Angeles Prehospital Stroke Scale (LAPSS)**

CI: Confidence interval; RR: Risk ratio; MD: Mean difference; OR: Odds ratio; IV TPA: Intravenous tissue Plasminogen Activator

**Question:** LAPSS compared to Standard assessment for Adults with suspected acute stroke

**Bibliography:** Wojner-Alexandrov, 2005 [24]

**Explanations:** a- Downgrade for serious risk of bias for selection of participants; b- The LAPSS is used for paramedics’ decision. The assessment is not limited only to the LAPSS.
| Certainty Assessment | No. of Patients | Effect |
|----------------------|-----------------|--------|
|                       |                 |        |
| **Ischemic stroke patients arriving <3 hours** |                 |        |
| 1 observational studies | very serious | not serious | not serious | none | 178/554 (32.1%) | 69/307 (22.5%) | RR 1.43 (1.12 to 1.82) | 97 more per 1000 (from 27 more to 184 more) | ◯◯◯◯ VERY LOW CRITICAL |
| **Rate of tPA administration (all patients)** |                 |        |
| 1 observational studies | very serious | not serious | not serious | none | 56/554 (10.1%) | 18/307 (5.9%) | RR 1.72 (1.03 to 2.88) | 42 more per 1000 (from 2 more to 110 more) | ◯◯◯◯ VERY LOW IMPORTANT |
| **Diagnosis ischemic stroke** |                 |        |
| 1 observational studies | very serious | not serious | not serious | none | 290/554 (52.3%) | 145/307 (47.2%) | RR 1.11 (0.96 to 1.28) | 52 more per 1000 (from 19 fewer to 132 more) | ◯◯◯◯ VERY LOW IMPORTANT |

**TABLE 15: Evidence profile table for Ontario Prehospital Stroke Scale (OPSS)**

CI: Confidence interval; RR: Risk ratio; OR: Odds ratio; IV TPA: Intravenous tissue Plasminogen Activator

**Question**: OPSST compared with standard assessment for adults with suspected acute stroke

**Bibliography**: Chenkin, 2009 [29]

**Explanations**: a- Very serious risk of bias due to deviation from intended interventions, missing data and confounding factor
| Certainty Assessment | No. of Patients | Effect | Certainty | Importance |
|----------------------|-----------------|--------|------------|------------|
| No. of studies | Study design | Risk of bias | Inconsistency | Indirectness | Imprecision | Other considerations | FASTER | Standard assessment | Relative (95% CI) | Absolute (95% CI) |
| Symptom onset to treatment time | 1 observational studies | very serious a | not serious | not serious | serious b | none | 17 | 17 | - | MD 32 min fewer (53 fewer to 11 fewer) | ⬤⬤⬤⬤ VERY LOW CRITICAL |
| Door to CT time | 1 observational studies | very serious a | not serious | not serious | serious b | none | 17 | 17 | - | MD 30 min fewer (50 fewer to 11 fewer) | ⬤⬤⬤⬤ VERY LOW CRITICAL |
| Door to needle time | 1 observational studies | very serious a | not serious | not serious | serious b | none | 17 | 17 | - | MD 46 min fewer (71 fewer to 21 fewer) | ⬤⬤⬤⬤ VERY LOW CRITICAL |
| Onset to door | 1 observational studies | very serious a | not serious | not serious | serious b | none | 17 | 17 | - | MD 17 min more (7.3 fewer to 41 more) | ⬤⬤⬤⬤ VERY LOW CRITICAL |
| Rate of thrombolytic therapy | 1 observational studies | very serious a | not serious | not serious | serious b | none | 22/115 (19.1%) | 5/67 (7.5%) | RR 2.56 (1.02 to 6.45) | 116 more per 1 000 (from 1 more to 407 more) | ⬤⬤⬤⬤ VERY LOW IMPORTANT |

TABLE 16: Evidence profile table for Face, Arm, Speech Time, Emergency Response Protocol (FASTER)

CI: Confidence interval; MD: Mean difference; RR: Risk ratio

Explanations: a- Very serious risk of bias due to confounding and selection for the reported result; b- Serious imprecision due to incomplete data reporting

Question: FASTER compared to Standard assessment for Adults with suspected acute stroke

Bibliography: O’Brien, 2012 [20]
| Certainty Assessment | No. of Patients | Effect | Certainty | Importance |
|----------------------|----------------|--------|------------|------------|
| **Certainty Assessment** | **No. of Patients** | **Effect** | **Certainty** | **Importance** |
| **No. of studies** | **Study design** | **Risk of bias** | **Inconsistency** | **Indirectness** | **Imprecision** | **Other considerations** | **FAST** | **Standard assessment** | **Relative (95% CI)** | **Absolute (95% CI)** |
| Rate of patients admitted <3 h with stroke diagnosis |
| 1 | observational studies | very serious | not serious | not serious | not serious | none | 66/137 (48.2%) | 32/219 (14.6%) | 336 more per 1000 (from 188 more to 548 more) | ⚫⚫⚫◯ | VERY LOW |

**TABLE 17: Evidence profile table for Face, Arm, Speech, Time to Call (FAST) Scale**

Cl: Confidence interval; RR: Risk ratio

**Question:** FAST compared to Standard assessment for Adults with suspected acute stroke

**Bibliography:** Harbison, 2003 [33]

**Explanations:** a- Fast is integrated in a specific protocol call "rapid ambulance protocol" and compared with PCDs and ED doctor’s diagnosis of stroke. No information about confounding factors.

| Certainty Assessment | No. of Patients | Effect | Certainty | Importance |
|----------------------|----------------|--------|------------|------------|
| **Certainty Assessment** | **No. of Patients** | **Effect** | **Certainty** | **Importance** |
| **No. of studies** | **Study design** | **Risk of bias** | **Inconsistency** | **Indirectness** | **Imprecision** | **Other considerations** | **Knowledge on FAST symptoms** | **Placebo** | **Relative (95% CI)** | **Absolute (95% CI)** |
| Before education and immediately after |
| 1 | observational studies | not serious | not serious | not serious | serious a | none | 68/72 (94.4%) | 55/72 (76.4%) | RR 1.24 (1.07 to 1.42) | 183 more per 1000 (from 53 more to 213 more) | ⚫⚫⚫⚫ | MODERATE |
| After education and 3 months after |
| 1 | observational studies | not serious | not serious | not serious | serious a | none | 63/65 (96.9%) | 64/65 (98.5%) | RR 0.98 (0.93 to 1.04) | 20 fewer per 1000 (from 69 fewer to 39 more) | ⚫⚫⚫⚫ | MODERATE |

**TABLE 18: Evidence profile table for increased public/layperson recognition of signs of stroke**

Cl: Confidence interval; RR: Risk ratio; OR: Odds ratio

**Question:** Knowledge on FAST symptoms Pretest and Posttest Survey Results

**Bibliography:** Wall, 2008 [23]

**Explanations:** a- Only one study is about cognitive knowledge. This research identifies messages with evidence-based effectiveness for communicating stroke signs and symptoms. The population is limited to non-Hispanic white and non-Hispanic black women aged 40 to 64 years.
Evidence profile tables for diagnosis studies are presented in Tables 19-22.

| Sensitivity | 0.86 (95% CI: 0.69 to 0.94) | Prevalence | 52.18% |
|-------------|---------------------------|------------|--------|

**Outcome**

| No. of studies (No. of patients) | Study design | Factors that may decrease certainty of evidence | Effect per 1000 patients tested | Test accuracy CoE |
|---------------------------------|--------------|-----------------------------------------------|---------------------------------|-------------------|
|                                 |              | Risk of bias | Indirectness | Inconsistency | Imprecision | Publication bias |                           |                  |
| True positives (patients with stroke and TIA) | 4 studies | cohort & case-control type studies | serious | serious | serious | not serious | none | 449 (360 to 490) | VERY LOW |
| False negatives (patients incorrectly classified as not having stroke and TIA) | 4 studies | cohort & case-control type studies | serious | serious | serious | not serious | none | 73 (32 to 162) |                  |
| True negatives (patients without stroke and TIA) | 4 studies | cohort & case-control type studies | serious | serious | serious | not serious | none | 182 (77 to 316) |                  |
| False positives (patients incorrectly classified as having stroke and TIA) | 4 studies | cohort & case-control type studies | serious | serious | serious | not serious | none | 296 (162 to 401) |                  |

**TABLE 19: Evidence profile table for Face, Arm, Speech, Time to Call (FAST) Scale**

**Question:** Should FAST analysis be used to diagnose stroke and TIA in patients suspected of stroke?

**Bibliography:** Berglund, 2014 [27]; Bergs, 2010 [14]; Fothergill, 2013 [17]; Pickham, 2019 [21]

Explanations: a- three studies have high risk of bias for patient selection, one has high risk of bias for reference standard, two have moderate risk of bias for reference standard and one has moderate risk of bias for flow and timing; b- One study includes the FAST in a protocol and does not test FAST only (Bergs, 2010); c- Inconsistency is considered as serious due to differences in study cohorts, qualification and training of test administrators, and differences in the reference standard.

TIA: Transient ischemic attack
TABLE 20: Evidence profile table for Los Angeles Prehospital Stroke Scale (LAPSS)

Question: Should LAPSS analysis be used to diagnose stroke and TIA in patients suspected of stroke?

Bibliography: Asimos, 2014 [26]; Bergs, 2010 [14]; Bray, 2005 [15]; Chen, 2013 [16]; Kidwell, 2000 [18].

Explanations: a- Very serious risk of bias due to high risk for patient selection (4/5) and reference standard, Moderate risk of bias due to reference standard (2/5) and flow and timing (1/5).

TIA: Transient ischemic attack
### TABLE 21: Evidence profile table for Cincinnati Prehospital Stroke Scale (CPSS)

**Question:** Should CPSS be used to diagnose stroke and TIA in patients suspected of stroke?

**Bibliography:** Asimos, 2014 [26]; Bergs, 2010 [14]; Bray, 2010 [28]; Bray, 2005 [19]; Frendl, 2009 [31]; Kothari, 1999 [25]; Ramanujam, 2008 [30]; English, 2018 [30]; Kim, 2017 [19]; Studnek, 2013 [36].

**Explanations:** a- High risk of bias for patient selection (9 studies on 10) and unclear risk of bias for reference standard (8 studies on 10) and for flow and timing (9 studies on 10)

TIA: Transient ischemic attack

| Outcome | Study design | No. of studies (No. of patients) | Factors that may decrease certainty of evidence | Test accuracy CoE | Pre-test probability of 41.41% |
|---------|--------------|----------------------------------|-----------------------------------------------|------------------|---------------------------------|
| - True positives (patients with stroke and TIA) | Cross-sectional (cohort type accuracy study) | 10 studies 1-10 2088 patients | Very serious a | | |
| - False negatives (patients incorrectly classified as not having stroke and TIA) | Cross-sectional (cohort type accuracy study) | 8 studies 1-10 83 patients | Very serious a | | |
| - True negatives (patients without stroke and TIA) | Cross-sectional (cohort type accuracy study) | 10 studies 1-10 2812 patients | Very serious a | | |
| - False positives (patients incorrectly classified as having stroke and TIA) | Cross-sectional (cohort type accuracy study) | 10 studies 1-10 214 patients | Very serious a | | |

**Sensitivity** 0.81 (95% CI: 0.70 to 0.89)

**Specificity** 0.55 (95% CI: 0.39 to 0.69)

**Prevalence** 43.45%
| Outcome | No. of studies (No. of patients) | Study design | Factors that may decrease certainty of evidence | Effect per 1000 patients tested | Test accuracy COE |
|---------|-------------------------------|--------------|-----------------------------------------------|-------------------------------|-----------------|
| True positives (patients with stroke and TIA) | 3 studies\(^1\)\(^-\)\(^3\) 291 patients | Cross-sectional (cohort type accuracy study) | | 252 (234 to 267) | LOW |
| False negatives (patients incorrectly classified as not having stroke and TIA) | | | | 45 (30 to 63) | |
| True negatives (patients without stroke and TIA) | 3 studies\(^1\)\(^-\)\(^3\) 690 patients | Cross-sectional (cohort type accuracy study) | | 577 (485 to 640) | LOW |
| False positives (patients incorrectly classified as having stroke and TIA) | | | | 126 (63 to 218) | |

**TABLE 22: Evidence profile table for Melbourne Ambulance Stroke Scale (MASS)**

**Question:** Should MASS be used to diagnose stroke and TIA in patients suspected of stroke?

**Bibliography:** Bergs, 2010 [14]; Bray, 2005 [15]; Bray, 2010 [28]

**Explanations:** a - serious risk of bias due to patient selection and unclear risk of bias due to reference standard and flow and timing

TIA: Transient ischemic attack

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**Additional Information**

**Disclosures**

**Human subjects:** All authors have confirmed that this study did not involve human participants or tissue.

**Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue.

**Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: Funding for the submission fees to CUREUS.COM was provided by the French Red Cross and the Global First Aid Reference Center. No other funding was requested or required for this review. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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