APPENDIX TWO: Prehospital Stroke Screening Tools

Table 2A: Standardized Acute Pre-Hospital Stroke Screening Tools

Assessment Tool Author	Items/Scoring	Sample	Reference Standard	Results (validity & reliability)
Cincinnati Pre-Hospital Stroke Scale (CPSS) **Kothari et al. 1999**	3 items: presence/absence of facial palsy; unilateral arm weakness; and speech impairment. Items simplified versions from the NIHSS. Abnormality demonstrated on one or more items is indicative of suspected stroke	171 patients with suspected stroke recruited through ED and inpatient neurology units. Mean age was 57.8 years, 58% male. Stroke/TIA prevalence: 49 (28.7%) Patients were assessed by 24 prehospital care providers (17 paramedics and 7 EMTs) and 2 NIH certified physicians, resulting in 860 total assessments.	Final discharge diagnosis of stroke	**Validity** Physicians: Sensitivity 1 abnormality 66%, 95% CI 49-80% 2 abnormalities 26%, 95% CI 14-43% 3 abnormalities 11%, 95% CI 3-26% Physicians: Specificity 1 abnormality 87%, 95% CI 80-92% 2 abnormalities 95%, 95% CI 90-98% 3 abnormalities 99%, 95% CI 95-100% Prehospital care workers: Sensitivity 1 abnormality 59%, 95% CI 51-67% 2 abnormalities 27%, 95% CI 21-35% 3 abnormalities 13%, 95% CI 8-20% Prehospital care workers: Specificity 1 abnormality 88%, 95% CI 86-91% 2 abnormalities 96%, 95% CI 94-97% 3 abnormalities 98%, 95% CI 96-99% The validity of this scale has been evaluated further, by both the scale developers and independent researchers. **Reliability** ICC for total scores among all prehospital workers was 0.92, 95% CI 0.89-0.93 ICC for total scores between prehospital workers and physicians was 0.92, 95% CI 0.89-0.93
Face Arm Speech Test	3 items derived from the CPSS: facial palsy, arm weakness, speech	487 patients admitted by ambulance, primary	WHO criteria	**Validity** Sensitivity: Diagnostic sensitivity of FAST associated

Assessment Tool Author	Items/Scoring	Sample	Reference Standard	Results (validity & reliability)
(FAST) **Harbinson et al 2003**	disturbance. Assessment of speech is not dependent on the repetition of a stock phrase, as per CPSS, but assessed during by EMS during normal conversation with the patient. Abnormality demonstrated on one or more items is indicative of suspected stroke	care physicians and ED referrals with suspected stroke. Mean age was 72 years, 52% were female Stroke/TIA prevalence: 356 (73.1%). FAST was completed by paramedics over a 6-month period		with paramedic use was estimated to be 79%. PPV (arrival by ambulance): 78%, 95% CI 72-84% The validity of this scale has been evaluated further, by independent researchers. **Reliability** Not assessed in this publication, but has been subsequently evaluated.
Los Angeles Prehospital Stroke Screen (LAPSS) **Kidwell et al. 2000 (Prospective validation study)**	6 items: 4 screening/history items (age>45 years, no history of seizures, symptom duration <24 hours, ambulation status at baseline not bedridden or wheelchair bound), blood glucose (between 60 and 400) level, a clinical assessment (of 3 items to identify obvious asymmetry: facial palsy, grip, arm strength). If the patient has positive criteria, a blood glucose level within the specified range and unilateral weakness on the clinical exam items, they are a positive screen for stroke.	206 patients (of 1,298 total runs) with neurological symptoms, who were noncomatose, with nontraumatic cause, who had a LAPSS screen conducted. Mean age was 67 years, 52% were male. Stroke/TIA prevalence: 36 (17.5%) LAPSS was completed by 18 paramedics over a 7-month period.	Hospitalized patients with final diagnosis of stroke	**Validity** Sensitivity: 91%, 95% CI 76-98% Specificity: 97%, 95% CI 93-99%) PPV: 86%, 95% CI 70-95% NPV: 98%, 95% CI 95-99% Accuracy: 96%, 95% CI 92-98% + LR: 31, 95% CI 16-147 - LR: 0.09, 95% CI 0-0.21 This validity of this scale has been evaluated further, by both the scale developers and independent researchers. **Reliability** Not assessed
Ontario Prehospital Stroke Screen (OPSS) Chenkin et al. 2009	At least one of the following symptoms must be present: unilateral leg/arm weakness or drift; slurred speech or muteness; unilateral facial droop), and the patient can be transported to arrive at a stroke centre within 3.5 hours of symptom onset.	325 patients transported to a stroke centre, who had been screened as positive by paramedics using the OPSS. Patients were identified through a National Stroke Registry. Mean age was 73.7 years, 47.4% were male.	Final discharge diagnosis	**Validity** Since all patients included in the sample, were screened as positive, sensitivity and specificity could not be calculated. PPV for acute stroke (1,2, or 3 positive signs): 89.5%, 95% CI 85.7-92.7% No additional validation studies have been conducted on this scale. **Reliability**

Assessment Tool Author	Items/Scoring	Sample	Reference Standard	Results (validity & reliability)
		Stroke prevalence: 187 (58%) An unknown number of EMS workers conducted OPSS over a one-year period		Not assessed
Melbourne Ambulance Stroke Screen (MASS) **Bray et al. 2005**	Combination of items from CPSS and LAPSS. The presence of any physical assessment item + a response of "yes" to all history items indicates a positive screen	100 MASS assessments were conducted on patients with suspected stroke (total of 5,957 paramedic calls during the study period) Stroke/TIA prevalence: 73 (73%) 18 paramedics conducted MASS assessments over a one-year period	Final discharge diagnosis	**Validity** Sensitivity: 90%, 95% CI 81-96% Specificity: 74%, 95% CI 53-88% PPV: 90%, 95% CI 81-96% NPV: 745, 95% CI 53-88% +LR: 3.49, 95% CI 1.83-6.63 -LR: 0.13, 95% CI 0.06-0.27 Accuracy: 86% (Validity of LAPSS and CPSS was also assessed. CPSS had highest sensitivity at 95%, LAPSS had highest specificity at 85%) This validity of this scale has been evaluated further, by the scale developers. **Reliability** Not assessed
Medic Prehospital Assessment for Code Stroke (MedPACS) **Studneck et al. 2013**	The scale was developed by combining the strongest elements of CPSS and LAPSS and included: eligibility criteria-no prior history of seizure; onset of symptoms ≤25 hours, blood glucose 60-400 mg/mL and a physical exam (facial droop, arm/leg weakness; speech difficulty; and gaze preference) The presence of any physical assessment item + a response of "yes" to at least one eligibility criterion item indicates a positive screen	416 patients with suspected stroke, transported to one of 7 hospitals. Mean age was 66.8 years, 45.7% were male. Stroke prevalence: 186 (44.7%) EMS reports and stroke GWTG-S registries were reviewed over a 6-month period	Final discharge diagnosis	**Validity** Sensitivity: 74.2%, 95% CI 67.2-80.2% Specificity: 732.6%, 95% CI 26.7-39.1% PPV: 47.1%, 95% CI 41.3-53.0% NPV: 61.0, 95% CI 51.8-69.6% + LR: 1.10, 95% CI 0.973-1.24 - LR: 0.791, 95% CI 0.582-1.07 The validity of the CPSS was also assessed (SN: 79%, SP: 24%) No additional validation studies have been conducted on this scale. **Reliability** Not assessed

Assessment Tool Author	Items/Scoring	Sample	Reference Standard	Results (validity & reliability)
Recognition of Stroke in the Emergency Room Scale (ROSIER) **Nor et al. 2005**	7-items: 2 clinical history items (loss of consciousness, convulsive fits/syncope) and 5 neurological signs of stroke (facial palsy/weakness, arm weakness, leg weakness, speech disturbance and visual field defect). A -1 is awarded for each clinical history item present and a +1 for each neurological sign. Total scores range from -2 to +5. A score >0 is associated with possible stroke.	160 consecutive patients with suspected stroke presenting to the Emergency Department (ED) Stroke/TIA prevalence: 101 (63.1%) Assessments were conducted by ED physicians during a one-year period	Final diagnosis made by stroke consultant after review of symptoms and imaging findings	**Validity** (Prospective validation study) Sensitivity: 93%, 95% CI 89-97% Specificity: 83%, 95% CI 77-89% PPV: 90%, 95% CI 85-98% NPV: 88%, 95% CI 83-93% (Validity of LAPSS, FAST and CPSS was also assessed. CPSS had highest sensitivity at 85%, LAPSS had highest specificity at 85%). The validity of this scale has been evaluated further by independent researchers. **Reliability** Not assessed

PPV: Positive Predictive Value; NPV: Negative Predictive Value; LR Likelihood Ratio

Table 2B: Additional Screening Tools: Glasgow Coma Scale

Assessment Tool	Number and description of Items	Time to Administer	Reliability/validity	Interpretation of Scores	Sensitivity and Specificity	Training Required
Glasgow Coma Scale (GCS) Teasdale & Jennett 1974[1]	15 items in 3 categories: motor response (6 items), verbal response (5 items), and eye opening (4 items). Points are awarded for the best response in each category. Categories are summed to provide a total score.	Approximately 1 minute.	**Interobserver reliability**: Scale authors reported low rates of disagreement, but noted variations in motor responses based on stimulus used [2]. Reported agreements ranged 0.48 (verbal) to 0.72 (eye opening)[3] and from 0.39 – 0.79.[4] Percentage agreements have been reported as 90% overall, and as ranging from 83.8% (eye opening, right) to 98.7% (best motor response – left).[5] In addition, similar rates of between observer agreement	GCS scores range from 3 – 15, where 3 represents total unresponsiveness and 15 represents alert and fully responsive. Scores may be divided into categories by severity: 13-15 = mild; 9-12=moderate and ≤8 represents severe injury. [21]	Not reported	Yes.

Assessment Tool	Number and description of Items	Time to Administer	Reliability/validity	Interpretation of Scores	Sensitivity and Specificity	Training Required
			have been reported in groups of experienced nurses (98.6% - 100%), newly graduated nurses (94.3%-96.2%) and student nurses (77.3% - 100%).[6] **Construct Validity**: In review of GCS, evidence supports association between extent of brain damage and depth of coma as assessed on GCS. GCS scores significantly associated with length of coma ($p<0.0001$). [7] **Predictive Validity**: GCS score is a significant predictor of death following stroke [8, 9] or traumatic brain injury (modified by age and mechanism of injury) [10], though eye-opening may be less strongly associated than either the motor or verbal score components[11]. GCS scores are also predictive of survival (AUC=0.89), though eye-opening may not add to predictive accuracy [12]. GCS scores have been demonstrated to be predictive of Glasgow Outcome scores at 6 months to 1 year post injury [7, 13-16], Disability Rating Scale scores at discharge [17] and at 6 months[18], FIM scores at discharge[17, 19] and employment status at one-year[20].			

Table 2C. Prehospital Stroke Severity Scales

Assessment Tool Author	Items/Scoring	Sample	Reference Standard	Results
Field Assessment Stroke Triage for Emergency Destination (FAST-ED) **Lima et al. 2016**	6-items, 5 based on NIHSS 1. Facial palsy (0-1) 2. Arm weakness (0-2) 3. Speech changes (0-2) 4. Eye deviation (0-2) 5. Denial/neglect (0-2) 6. Time (documentation for decision making) not scored Total possible score: 9	741 consecutive patients enrolled in the STOPStroke study, who were admitted to 2 university-based hospitals with unilateral, complete occlusion of the M1 and M2 segments of the MCA or basilar artery, with onset of symptoms within 24 hours. Prevalence of LVO: 240 (33%)	CTA	A cut-point of ≥4 on FAST-ED had best performance Sensitivity: 0.61 Specificity: 0.83 PPV: 0.72 NPV: 0.82 Accuracy: 0.79 AUC:0.813 Performance of FAST-ED was also compared with NIHSS, RACE and CPSS scale
FAST-VAN **Wasyliw et al. 2018**	FAST + VAN (see description below)	172 consecutive stroke patients recruited from a single centre.	CTA	80 patients were positive for LVO, 58 were negative, based on CTA. PPV was 58%
Vision, Aphasia, and Neglect (VAN) **Teleb et al. 2016**	Patients are asked to raise both arms up and hold them up for 10 s. If the patient demonstrates any level of drift, weakness or paralysis, the assessment continues. Otherwise, patient is VAN -ve and screen ends. **Items** Visual disturbances: field cut, double vision, new-onset blindness (present/absent) Aphasia: Expressive, receptive, mixed (present/absent) Neglect: Forced gaze, unable to	62 acute stroke codes at a single facility Prevalence of LVO: 19 (30.6%)	CTA	Performance of VAN was also compared with NIHSS ≥6 For VAN +ve patients Sensitivity: 1.00 Specificity: 0.90 PPV: 0.74 NPV: 1.00 Accuracy: 0.92 NIHSS≥6 Sensitivity: 1.00 Specificity: 0.79 PPV: 0.58 NPV: 1.00 Accuracy: 0.84

Assessment Tool Author	Items/Scoring	Sample	Reference Standard	Results
	feel both sides at same time or doesn't recognize arm, ignoring one side (present/absent) Scoring: None If weakness present + ≥1 positive finding =VAN +ve			
Prehospital Acute Stroke Severity Scale (PASS) **Hastrup et al. 2016**	3 NIHSS items: 1. Incorrect month and/or age? (Level of consciousness (NIHSS item >0) 1 point 2. Gaze palsy and/or deviation (NIHSS item gaze>0) 1 point 3. Arm weakness (NIHSS item arm weakness >0) 1 point Total possible score: 3	3,127 patients included in the Danish Stroke Registry (2010-2015) who were treated with t-PA. 2/3 of sample was used for scale development and 1/3 for validation Prevalence of LVO: 35%	CTA/MRA	A cut-point of ≥2 on the PASS had the best predictive value: Using the Derivation cohort Sensitivity 0.66, 95% CI 0.62-0.66 Specificity: 0.83, 95% CI 0.81-0.85 AUC: 0.74, 95% CI 0.72-0.76 OR=9.22, 95% CI 7.5-11.40 PPV/NPV: 0.68/0.81 +LR/-LR: 3.84/0.42 The values were similar when using the validation cohort
The Los Angeles Motor Scale (LAMS) **Nazliel et al. 2008**	3 items: 1. Facial droop (absent=0, present=1) 2. Arm drift (absent=0, drifts down=1, falls rapidly=2) 3. Grip strength (normal=0, weak=1, no grip=2) Total possible score 5	119 patients included in a clinical trials registry at a stroke centre from 1996-2003, and patients included in the Get with the Guidelines Registry in 2005. Patients were included if they were last known well within 12 hours of presentation to the ED and had a final diagnosis of ischemic stroke in the anterior circulation Prevalence of LVO: 74 (62%)	MRA/CTA, or catheter angiography	AUC: 0.854 A cut point of ≥4 had the best predictive value for detecting LVO Sensitivity: 81% Specificity: 89% Accuracy: 85% +LR: 7.36 -LR: 0.21
Cincinnati Prehospital Stroke Severity Scale	3 NIHSS items: 1. Conjugate gaze deviation (≥1 on NIHSS item for gaze) 2	Derivation cohort-624 patients with mild to severe stroke from 2 NINDS t-PA trials.	CTA	**Severe stroke** AUC: 0.89 A cut point of ≥2 had the best predictive value for severe stroke

Assessment Tool Author	Items/Scoring	Sample	Reference Standard	Results
(CPSSS) **Katz et al. 2015**	points 2. Incorrectly answers to at least 1 of 2 LOC questions (NIHSS age or current month) and does not follow at least 1 of 2 commands (close eyes, open and close hand) ≥1 NIHSS items LOC 1b and 1c. 1 point 3. Cannot hold arm (left, right or both) up for 10 seconds (≥2 NIHSS motor arm). 1 point Total possible score 4	Validation cohort-650 patients from the IMS-III trial Prevalence of LVO: 34% (validation cohort)		Using the derivation cohort Sensitivity: 89% Specificity: 73% + LR/-LR: 3.30/0.15 Using the validation cohort: Sensitivity: 92% Specificity: 51% + LR/-LR: 1.89/0.1
Pérez de la Ossa et al. 2014 **Rapid Arterial oCclusion Evaluation Scale (RACE)**	5 NIHSS items: 1. Facial palsy (absent=0, mild=1, mod/severe=2) 2. Arm motor function (normal/mild=0, moderate=1, severe=2) 3. Leg motor function (normal/mild=0, moderate=1, severe=2) 4. Head and gaze deviation (absent=0, present=1) 5. Aphasia (R hemiparesis: performs both tasks correctly=0, performs 1 task correctly=1, performs neither tasks=2); Agnosia (Left hemiparesis: patient recognizes arm/impairment=0, does not recognize arm *or* impairment=1, does not recognize arm *and* impairment=2) Total possible score 9	Derivation cohort-654 patients with acute stroke or stroke mimic for whom a stroke code had been activated by EMS or a community hospital. Validation cohort-357 patients transferred by EMS to a stroke centre Prevalence of LVO: 178 patients (27%) had a LVO in derivation cohort vs. 76 (21.3%) in the validation cohort.	Transcranial Doppler, CT or MRA	In the derivation cohort, there was a strong correlation between RACE and NIHSS (r=0.76, p<0.01) In the validation cohort, a cut point of ≥5 had the best predictive value for detecting LVO Sensitivity: 85% Specificity: 68% PPV: 42% NPV: 94% The AUC for the RACE scale was 0.82, 95% CI 0.77-0.87 for the detection of LVO
3-Item Stroke Scale (3ISS)	3 items: Disturbance of consciousness (no=	180 patients presenting to a stroke unit in 2002 with symptoms of stroke	MRI/MRA/CT	A cut point of ≥4 had the best predictive value for detecting MCA occlusions Sensitivity: 67%

Assessment Tool Author	Items/Scoring	Sample	Reference Standard	Results
Singer et al. 2005	0, mild =1, severe= 2) Gaze and head deviation (absent= 0, incomplete gaze/head deviation=1, forced gaze/head deviation= 2) Hemiparesis (absent=0, moderate=1, severe= 2) Total possible score 6	within ≤6 hours (28 patients had ICH). Prevalence of LVO: 27 (15%)		Specificity: 92% PPV: 74% NPV: 89% Accuracy: 86% Inter-rater reliability: Intraclass correlation co-efficient was 0.947; K for individual items were 0.77, 0.77 and 0.84

PPV: Positive Predictive Value; NPV: Negative Predictive Value; LR Likelihood Ratio; AUC Area under curve

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Table 2C References

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Useful links:

1) **CPSS** http://www.strokecenter.org/wp-content/uploads/2011/08/cincinnati.pdf This is a direct link to a copy of the scale.
2) http://www.strokeassociation.org/idc/groups/stroke-public/@wcm/@private/@hcm/@gwtg/documents/downloadable/ucm_428607.pdf This is an American Stroke Association link to a handout that provides complete instructions for non-medical individuals to administer the CPSS to someone in whom a stroke is suspected.
3) http://www.acep.org/uploadedFiles/ACEP/Practice_Resources/disater_and_EMS/EMS_week/ems_week_materials/08factsheets.pdf The second page on this link has “cards” for the CPSS and the LAPSS.
4) http://www.strokecenter.org/wp-content/uploads/2011/08/LAPSS.pdf Direct link a copy of the LAPSS scale.
5) There is a more detailed review of the GCS available at www.abiebr.com. There is also a review of the GCS posted at www.strokengine.ca.