Canadian Stroke Best Practices

CANADIAN STROKE BEST PRACTICE RECOMMENDATIONS

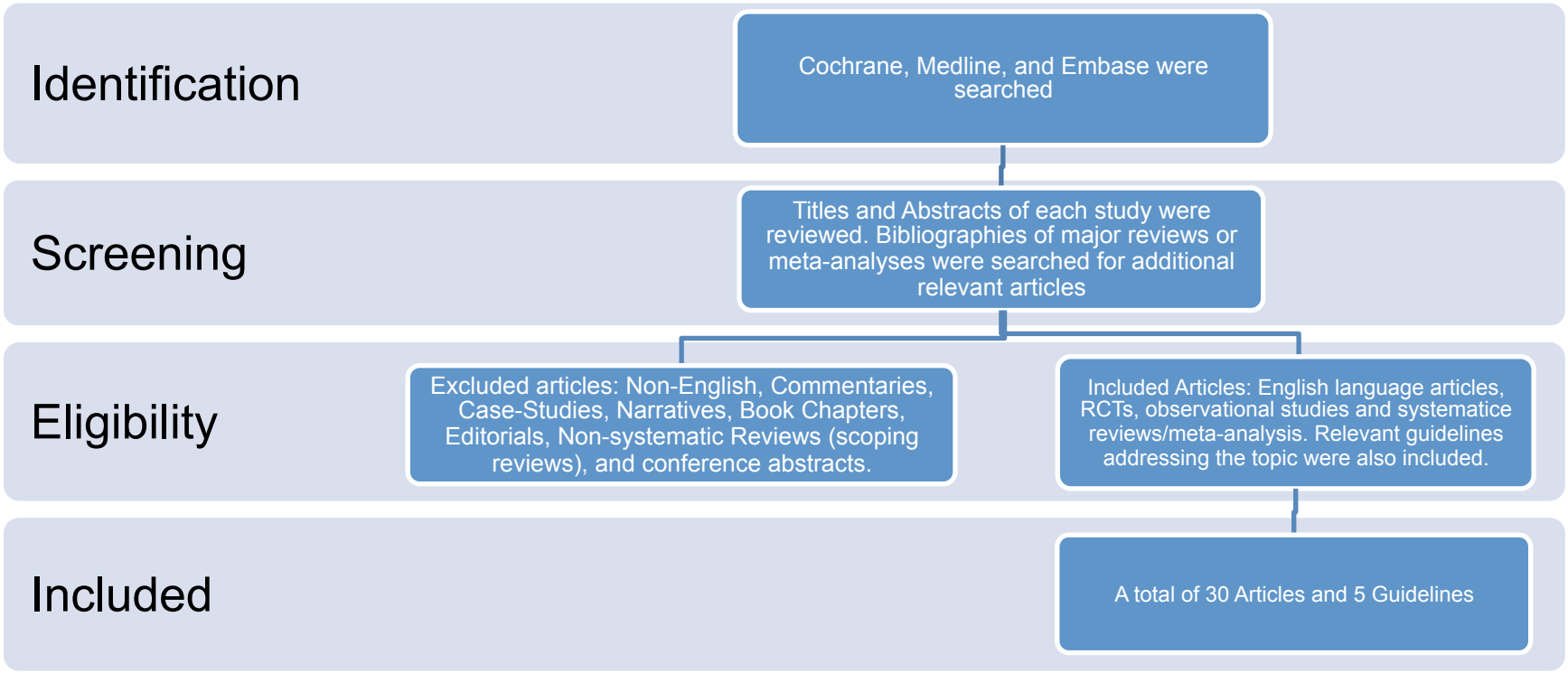
Acute Stroke Management Evidence Tables

Emergency Medical Services (EMS) Management of Acute Stroke Patients

Jean-Martin Boulanger and Kenneth Butcher (Writing Group Chairs)
on Behalf of the Canadian Stroke Best Practice Recommendations
ACUTE STROKE MANAGEMENT Best Practice Writing Group

Table of Contents

Search Strategy



Medline, Embase and the Cochrane Database were search using the terms ([Stroke OR Cerebrovascular Disorders] AND [Emergency Service, hospital OR Emergency Medicine OR Hyperacute]). Titles and abstract of each article were reviewed for relevance. Bibliographies were reviewed to find additional relevant articles. Articles were excluded if they were: non-English, commentaries, case-studies, narrative, book chapters, editorials, non-systematic review, or conference abstracts. Additional searches for relevant best practice guidelines were completed and included in a separate section of the review. A total of 30 articles and 5 guidelines were included and were separated into separate categories designed to answer specific questions.

Published Guidelines

Guideline	Recommendations
Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, Biller J, Brown M, Demaerschalk BM, Hoh B, Jauch EC, Kidwell CS, Leslie-Mazwi TM, Ovbiagele B, Scott PA, Sheth KN, Southerland AM, Summers DV, Tirschwell DL; on behalf of the American Heart Association Stroke Council. **2018 Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association.** ***Stroke.* 2018; Mar;49(3):e46-e110.** **(selected)**	**1. Prehospital Stroke Management and Systems of Care** **1.1 Prehospital Systems** 1. Public health leaders, along with medical professionals and others, should design and implement public education programs focused on stroke systems and the need to seek emergency care (by calling 9-1-1) in a rapid manner. These programs should be sustained over time and designed to reach racially/ethnically, age, and sex diverse populations. Class I; LOE B-R). 2. Activation of the 9-1-1 system by patients or other members of the public is strongly recommended. 9-1-1 dispatchers should make stroke a priority dispatch, and transport times should be minimized. (Class I; LOE B-NR). 3. To increase both the number of patients who are treated and the quality of care, educational stroke programs for physicians, hospital personnel, and EMS personnel are recommended. Class I; LOE B-NR). **1.2. EMS Assessment and Management** 1. The use of a stroke assessment system by first aid providers, including EMS dispatch personnel, is recommended. (Class I; LOE B-NR). 2. EMS personnel should begin the initial management of stroke in the field. Implementation of a stroke protocol to be used by EMS personnel is strongly encouraged. 3. EMS personnel should provide prehospital notification to the receiving hospital that a suspected stroke patient is en route so that the appropriate hospital resources may be mobilized before patient arrival. (Class I; LOE B-NR). **1.3. EMS Systems** 1. EMS leaders, in coordination with local, regional, and state agencies and in consultation with medical authorities and local experts, should develop triage paradigms and protocols to ensure that patients with a known or suspected stroke are rapidly identified and assessed by use of a validated and standardized instrument for stroke screening, such as the FAST (face, arm, speech test) scale, Los Angeles Prehospital Stroke Screen, or Cincinnati Prehospital Stroke Scale. (Class I; LOE B-NR). 2. Regional systems of stroke care should be developed. These should consist of the following: (a) Healthcare facilities that provide initial emergency care, including administration of IV alteplase, and, (b) Centers capable of performing endovascular stroke treatment with comprehensive periprocedural care to which rapid transport can be arranged when appropriate. (Class I; LOE A). 3. Patients with a positive stroke screen and/or a strong suspicion of stroke should be transported rapidly to the closest healthcare facilities that can capably administer IV alteplase. (Class I; LOE B-NR). 4. When several IV alteplase–capable hospital options exist within a defined geographic region, the benefit of bypassing the closest to bring the patient to one that offers a higher level of stroke care, including mechanical thrombectomy, is uncertain. Further research is needed. (Class IIb; LOE B-NR). **1.5. Hospital Stroke Teams** 1. An organized protocol for the emergency evaluation of patients with suspected stroke is recommended. Class I; LOE B-NR. 2. It is recommended that DTN time goals be established. A primary goal of achieving DTN times within 60 minutes in ≥50% of AIS patients treated with IV alteplase should be established. Class I; LOE B-NR.
Kobayashi A, Czlonkowska A, Ford GA, Fonseca AC, Luijckx GJ, Korv J, et al.	We recommend that all EMS technicians and paramedics are familiar with a simple pre -hospital stroke scale to identify potential stroke patients. No specific scale can be recommended. (SOR strong; low quality of evidence). There is insufficient evidence to recommend a pre -hospital stroke scale to predict large vessel occlusion.

Guideline	Recommendations
European Academy of Neurology - European Stroke Organisation consensus statement and practical guidance for pre-hospital management of stroke. ***Eur J Neurol* 2018 Mar;25(3):425-433.**	In patients with SaO 2 levels < 95% we suggest the administration of O 2 titrated to maintain normoxia. Routine use of O2 is not recommended. (SOR weak; very low quality of evidence) We do not recommend pre -hospital treatment of high blood pressure in people suspected with acute stroke. (SOR weak; very low quality of evidence). Because of safety concerns we do not recommend pre -hospital administration of insulin in persons with suspected stroke and hyperglycemia. (SOR weak; very low quality of evidence). In the absence of clinical studies no recommendations can be made on pre - hospital interventions for lowering elevated body temperature. We recommend that all EMS implement a 'code stroke' protocol, including highest priority dispatch, pre -hospital notification, and rapid transfer to the closest 'stroke - ready' center. (SOR strong; moderate quality of evidence). No recommendation on the additional value of pre -hospital telemedicine can be made. We do not recommend the routine use of mobile emergency stroke units because there is insufficient evidence that they lead to better functional outcome. (SOR weak; low quality of evidence) No recommendation on the use of pre -hospital POC laboratory analysis of blood count and INR can be made. No recommendation can be made on the use of currently available biomarkers in persons with a suspected stroke. We do not suggest air medical transport outside of settings where a pragmatic decision has been taken that geographical conditions favor air transport. (SOR weak; very low quality of evidence). We do not recommend the use of any neuroprotective intervention in persons with suspected acute stroke in the pre -hospital setting. (SOR strong; high quality of evidence).
Clinical Guidelines for Stroke Management 2017. Melbourne (Australia): National Stroke Foundation.	Strong recommendation Updated All stroke patients should be managed as a time critical emergency. The dispatch of ambulances to suspected stroke patients who may be eligible for reperfusion therapies requires the highest level of priority. Strong recommendation Updated • Ambulance services should preferentially transfer suspected stroke patients to a hospital capable of delivering reperfusion therapies as well as stroke unit care. • Ambulance services should pre-notify the hospital of a suspected stroke case where the patient may be eligible for reperfusion therapies. Practice point New General practitioners are encouraged to educate reception staff in the FAST stroke recognition message and to redirect any calls about suspected acute stroke to 000

Guideline	Recommendations
Intercollegiate Stroke Working Party. Royal College of Physicians. National Clinical guidelines for stroke. 5th Edition 2016, Edinburgh, Scotland	A-People seen by ambulance clinicians outside hospital with the sudden onset of focal neurological symptoms should be screened for hypoglycaemia with a capillary blood glucose, and for stroke or TIA using a validated tool. Those people with persisting neurological symptoms who screen positive using a validated tool should be transferred to a hyperacute stroke unit as soon as possible. B- People who are negative when screened with a validated tool but in whom stroke is still suspected should be treated as if they have stroke until the diagnosis has been excluded by a specialist stroke clinician. C- The pre-hospital care of people with suspected stroke should minimise time from call to arrival at hospital and should include a hospital pre-alert to expedite specialist assessment and treatment. D- Patients with suspected stroke whose airway is considered at risk should be managed appropriately with suction, positioning and airway adjuncts. E- Patients with residual neurological symptoms or signs should remain nil by mouth until screened for dysphagia by a specifically trained healthcare professional. F- Patients with suspected TIA should be given 300mg of aspirin immediately and assessed urgently within 24 hours by a specialist physician in a neurovascular clinic or an acute stroke unit. G- Patients with suspected stroke or TIA should be monitored for atrial fibrillation and other arrhythmias.
Institute for Clinical Systems Improvement (ICSI). Diagnosis and treatment of ischemic stroke. Bloomington (MN): Institute for Clinical Systems Improvement (ICSI); 2010 Jun. 70 p.	**Rapid Outpatient Evaluation or Admit to Hospital** Patients with TIA symptoms that occurred more than 24 hours ago but within the last seven days should be evaluated as soon as possible [R]. Organizations have started TIA clinics for the rapid evaluation of patients in the outpatient setting. Patients who cannot be evaluated rapidly as an outpatient should be admitted to the hospital. The following diagnostic evaluations should be performed within 48 hours: •Brain and vascular imaging [D], [R] MRI/MRA, CT/CTA, CT/carotid ultrasound, if symptoms referable to carotid distribution, consider echocardiogram, Laboratory tests, Fasting lipid profile, Fasting glucose, Consider hemoglobin A1c if suspect diabetes, Risk factor assessment and counseling **Emergency Department (ED) Treatment Algorithm Annotations** Consider IV Tissue Plasminogen Activator (tPA)/See Stroke Code Algorithm Key Points: •Treatment with IV tPA is proven therapy for patients having ischemic stroke. •Treatment with IV tPA should begin within three hours (180 minutes) or 4.5 hours (270 minutes) in selected patients. The eligibility for treatment in the 3 to 4.5-hour time window is similar to patients treated within 3 hours; with the following additional exclusions: •Patients older than 80 years – there is as yet inadequate data on the benefits in this age group •Patient taking oral anticoagulants regardless of international normalized ratio (INR)

Guideline	Recommendations
	•National Institutes of Health (NIH) stroke scale >25 •Patients with a history of stroke and diabetes •Patients with persisting symptoms presenting to the emergency department within 150 minutes (or 240 minutes in selected patients) of symptom onset should be evaluated rapidly for treatment with IV tPA. •Occasionally, patients may be able to receive IV tPA even if they present later than 150 minutes (240 minutes in selected patients) if their work-up, such as laboratory evaluation, has been completed and they have IV access in place. •Intra-arterial thrombolysis may be an option for treatment in selected patients who are not IV tPA candidates due to being beyond the 3 to 4.5-hour time window (see Annotation #30 section "Consider if Intra-Arterial Recanalization Candidate" below). Patients presenting to the emergency department soon after the onset of symptoms may be candidates for treatment with IV tPA and will therefore require a rapid evaluation and treatment initiation [R]. Although the time window from onset of symptoms to treatment can be up to 3 hours, i.e., 180 minutes (or 4.5 hours, i.e., 270 minutes in selected patients), the evaluation in the emergency department will require at least 30 minutes in most cases (CT scan of head, laboratory tests performed and results returned, IV access obtained, and neurological exam and history) [R]. The guideline work group has therefore chosen 150 minutes or 240 minutes in selected patients, as a practical cut-off time for this triage decision. There are important exceptions to this time limitation guideline for triage of the patients into the "Stroke Code" process. In certain instances, the time required for evaluation may be shorter and "Stroke Code" may be feasible for patients presenting as late as 165 or 170 (255-260 minutes in selected patients) minutes after onset. One example would be the patient who is already in the hospital and has undergone the appropriate laboratory evaluation, has an IV access in place, and much of the history is already known. In that case, a brief neurologic exam and rapid evaluation with CT may be the only items required prior to treatment and could theoretically be performed in 10 to 15 minutes. 21.Emergency Department (ED) Diagnostic Evaluation Patients with a history of clinical TIA should be evaluated promptly [R]. The following diagnostic evaluations should typically be performed [C], [D], [R]. The speed and venue of the assessment described below will depend on the currency of the symptoms and the physician's assessment of risk of early recurrence of clinical TIA or the development of stroke. The work group recommends that patients presenting less than 24 hours since initial TIA with high risk symptoms (see Annotation #23, "High Risk for Stroke?") generally not leave the emergency department until the following are completed or scheduled within the next few hours on an inpatient basis. Laboratory tests, Complete blood count, Electrolytes (sodium, potassium, chloride, CO2), blood urea nitrogen (BUN), creatinine, glucose, Prothrombin time/international normalized ratio, Activated partial thromboplastin time (aPTT), Cardiac biomarkers (troponin), Electrocardiogram, Brain and vascular imaging, MRI (preferred)/MRA, CT/CTA, CT/carotid ultrasound, if symptoms referable to carotid distribution **Brain Imaging** If the patient is not having symptoms at the time of presentation, a diffusion-weighted MRI (DW-MRI) is preferred, if available. Restricted proton diffusion in the setting of a clinical transient ischemic attack identifies higher risk of stroke. At this time, an MRA of the carotids and intracranial artery can be performed. If MRI is not available, a CT of the head would be indicated and, if feasible, a CTA of the head and neck can also be performed [B],

Guideline	Recommendations
	[D], [R]. Another approach for patients with symptoms referable to a carotid territory would be CT of the brain followed by carotid ultrasound as vascular imaging.

Evidence Tables

Hospital Prenotification

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Identification of Stroke					
Abboud et al. 2016 **USA** **Retrospective study**	NA	399 patients with a final diagnosis of stroke or TIA who arrived by EMS to the ED between 2009-2012. Median age was 63 yrs, 45.9% were male. Median NIHSS score was 6.	Process indicators were compared among 3 groups: EMS providers who did not recognize a stroke, EMS providers who did recognized a stroke but did not prenotify, and EMS providers who recognized a stroke and prenotified.	**Primary outcomes:** Pre-hospital and in-hospital time intervals	The final diagnoses at discharge were ischemic stroke (67.2%), hemorrhagic stroke (18.3%), and TIA (14.5%). EMS dispatches correctly identified 58.2% of all stroke cases (including TIAs) compared with 57.6% for EMS providers. The median door-to-physician and door-to-CT scan times for patients where stroke was recognized but without prenotification were significantly shorter compared with those patients where EMS did not recognize stroke (7 vs. 11 minutes, p<0.0014 and 28 vs. 48 minutes, p<0.001, respectively). EMS prenotification occurred in 40.4% of the stroke cases identified by EMS. The median door-to-physician and door-to-CT scan times for patients where stroke was recognized and with prenotification were significantly shorter compared with those patients with stroke without prenotification (2 vs. 7 minutes, p<0.001 and 19 vs. 28 minutes, p<0.001, respectively). In multivariable analysis, stroke recognition was associated with an increased likelihood of treatment with thrombolysis (OR=6.43, 95% CI 1.74-23.7, p=0.005), as was stroke recognition with prenotification (OR=4.44, 95% CI 1.23-16.01, p=0.023).
Caceres et al. 2013 **USA**	NA	52,282 stroke patients transported to hospital by ambulance.	Data from an administrative database was used to determine dispatcher suspected stroke coding, emergency	**Primary outcomes:** Time to scene, time at scene, time from scene to destination time, and total transportation time.	52.7% (n=27,566) of transported stroke patients were identified as suspected stroke patients by dispatchers. For those identified as having a suspected stroke by

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Retrospective study			medical technician diagnosis coding, and all aspects of transportation time.		dispatchers, time to scene (9.8 vs 11.7 min), time at scene (14.1 vs 15.6 min), time from scene to destination (16.4 vs 20.5 min), and total transportation time (41.8 vs 49.8) were all significantly reduced, compared to those diagnosed with stroke but not identified by dispatchers (all at p<0.001).
Watkins et al. 2013 **UK** **Historically controlled study**	NA	199 patients coded by emergency medical dispatchers as suspected stroke and/or who received a final diagnosis of stroke. 69 emergency medical dispatchers.	Emergency medical dispatchers completed training aimed at improving their ability to detect suspected stroke patients. The study period was divided into three periods: pre-implementation (9 weeks), during implementation (7 weeks), and post-implementation (10 weeks).	**Primary outcomes:** Proportion of patients with a final diagnosis of stroke dispatched as stroke.	Following the implementation period, 80% of stroke patients were identified as suspected stroke patients by dispatchers, as compared to 63% during the pre-implementation period (p<0.01). Compared to the pre-implementation period, the odds of dispatchers using a stroke code for patients with a final diagnosis of stroke were significantly increased during both the implementation (OR= 4.10, 95% CI 1.58 to 10.66) and post-implementation periods (OR= 2.3, 95% CI 1.07 to 4.92).
Stroke Management Indicators Associated with Prenotification					
McKinney et al. 2013 **US** **Retrospective study**	NA	229 patients included from a database of patients admitted to the emergency department with a possible acute stroke between January 2009 and June 2010. Mean age of patients was 65 years, 50% were male	The outcomes of 114 patients treated using hospital pre-notification were compared with 115 patients without hospital pre-notification. Hospital pre-notification involved informing emergency department physicians and other relevant personnel (blood and EKG technicians, radiologists and pharmacologists) of the arrival of a potential stroke patient with a time since symptom onset of less than 4.5 hours.	**Primary outcomes:** Times: from patient arrival to stroke team arrival, to CT completion and interpretation, to ECG, to availability of laboratory results, to making a treatment decision and receiving tPA. Analysis was adjusted for baseline variables and only included patients who arrived to hospital by EMS (i.e., excluded walk-ins)	Patients treated using pre-notification were significantly older (69.5 vs. 61.5 years, p=0.0002) and had higher mean NIHSS scores (11.1 vs. 6.9, p<0.0001) Mean time to stroke team arrival was significantly shorter for prenotification patients, (MD=16.4, 95% CI 12.8-20.0 minutes, p<0.001). Mean times to CT completion and interpretation were significantly shorter for prenotification patients (MD=11.7, 95% CI 6.9-16.4 minutes, p<0.0001 and MD=10.0, 95% CI 3.8-16.1 minutes, p=0.02, respectively). Mean decision time was non-significantly longer for pre-notification patients (-13.5, 95% CI -35.8 to -8.8, p=0.23). Although a higher proportion of prenotification

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					patients were treated with t-PA (27% vs. 15%), after accounting for baseline covariates, prenotification was not an independent predictor of treatment with t-PA (p=0.13).
Lin et al. 2012 **US** **Retrospective study**	NA	371,988 acute ischemic stroke patients consecutively admitted to 1,585 hospitals and transported by ambulance.	As part of the Get with the Guidelines-Stroke initiative, data collected included onset time of stroke, mode of arrival, time of arrival, and use of EMS pre-notification, and time-to-administration of thrombolysis.	**Primary outcomes:** Door-to-imaging time, door-to-needle time, onset-to-needle time.	67% (n=249,197) of participants arrived at hospital following a pre-notification, while 72% of those arriving within 4.5 hours of symptom onset had a pre-notification. Patients with EMS pre-notification had significantly shorter door-to-imaging time (26 vs 31 mins, p<0.001), door-to-needle time (78 vs 81 mins, p<0.001), and stroke onset-to-needle time (141 vs 145 mins, p<0.001). Of those who arrived at hospital within 2 hours of stroke onset, patients with a pre-notification were significantly more likely than those without to receive tPA within 3 hours of stroke onset (73% vs 64%, p<0.001).
Patel et al. 2011 **US** **Prospective registry**	NA	13,894 patients with any type of stroke were identified from prospective stroke register of which, 6300 (45%) patients arrived by private means and 7594 (55%) by EMS in 2008 and 2009.	Comparison of outcomes between three groups of patients (those arriving via private means, by EMS with pre-notification and EMS with no pre-notification). Note: 44% of patients did not have a time recorded for when their imaging results were interpreted.	**Primary outcomes**: Time between hospital arrival and completion of brain imaging and time between hospital arrival and interpretation of brain imaging. **Secondary outcome**: administration of tPA. Cut points for outcomes: based on targets of 25 minutes for imaging completion and 45 minutes for image interpretation.	<u>Adjusted analysis:</u> **Primary outcomes:** Patients arriving by EMS with hospital pre-notification had a greater likelihood of having brain imaging completed within 25 min (RR=3.0, 95% CI 2.1-4.1) and a greater likelihood of having brain imaging interpreted within 45 min (RR= 2.7, 95% CI 2.3-3.3) compared to arriving by private means. Patients arriving by EMS with no hospital pre-notification had a greater likelihood of having brain imaging completed within 25 min (RR= 1.9, 95% CI 1.6-2.3) and a greater likelihood of having brain imaging interpreted within 45 min (RR= 1.7, 95% CI 1.4-2.1) compared to arriving by private means. **Secondary outcome:** Patients eligible for tPA were more likely to receive it if arriving by EMS with pre-notification (RR 1.5, 95% CI 1.1-1.9) and EMS with no pre-notification (RR=1.6, 95% CI 1.4-2.0) compared to patients

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					arriving by private means.
Use of Thrombolysis					
Hsieh et al. 2016 **Taiwan** **Retrospective study**	NA	928 patients ≥20 years, treated by EMS technicians who were transported and treated at 9 hospitals from 2012-2014, with a final discharge diagnosis of +/- stroke or TIA, who arrived at hospital within 3 hours of the event	Process indicators were compared between patients who arrived at hospital with prenotification (n=727) and without prenotification (n=201). Prenotification occurred when a patient met criteria including: a positive Cincinnati Prehospital Stroke Scale, symptom onset within 3 hours and blood glucose of ≥60 mg/dL plus evidence of facial palsy, arm weakness or slurred speech.	**Primary outcome:** Door to CT scan **Secondary outcome:** Door to needle time	A greater proportion of patients arriving with prenotification were male (64.5% vs. 51.75, p=0.001) and more likely to have suffered a hemorrhagic stroke (34.4% vs. 32.8%, p<0.001). The stroke severity was non-significantly higher in the pre-notification group (median NIHSS 16 vs. 12.5, p=0.081). The median door to CT time was significantly shorter for prenotification patients (13 vs. 19 minutes, p<0.001). The proportion of prenotification patients who received a CT scan within 25 minutes of hospital arrival was also significantly higher (90.8% vs. 62.2%, p<0.001). Although a higher proportion of prenotification patients received thrombolytic therapy (19.8% vs. 12.4%, p=0.017), the median door to needle time was not significantly different between the prenotification and no prenotification groups (63 vs. 68 minutes, p=0.138). Patients who did not received thrombolytic therapy (in either group) were more likely to have a hemorrhagic stroke, >80 years of age or rapidly improved.
Kim et al. 2016 **Korea** **Retrospective study**	NA	274 patients admitted to a single stroke centre with a standardized stroke code with ischemic stroke or TIA, treated with t-PA from 2012-2015. Mean age was 67.5 years, 36.1% were female. Median NIHSS score was 9.	Process indicators of patients who arrived to hospital by EMS +/- prenotification (n=215) were compared with those arriving by private means without hospital prenotification (n=59).	**Primary outcomes:** Times associated with onset to admission, door-to-imaging, door-to-needle	**EMS vs. private transport** The median onset to hospital arrival time was significantly shorter in the EMS group (62 vs. 116 minutes. P<0.001). The proportion of EMS patients arriving within 60 minutes of symptom onset was significantly greater (49.3 vs. 18.6%, p<0.001). The median door-to-imaging time was not significantly different between groups (12 vs. 12 minutes, p=0.46). The median door-to-needle time was not significantly different between groups (28 vs. 28 minutes, p=0.99). The proportion of patients who

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					received t-PA ≤30 minutes after arrival did not differ between groups (57.7% vs. 62.7%, p=0.49). The median symptom onset-to-needle time was significantly shorter for EMS patients (93 vs. 153 minutes, p<0.001). **EMS with prenotification** Of the 215 patients who arrived by EMS, prenotification was used in 28 (13%) cases. There was no significant difference in the median onset- to-door time between patients who arrived with and without prenotification (60 vs. 62 minutes, p=0.24). The median door-to-imaging time was significantly shorter for patients who arrived with prenotification (9 vs. 12 minutes, p=0.045) The median door-to-needle time was significantly shorter for patients who arrived with prenotification (20 vs. 29 minutes, p=0.011).
Casolla et al. 2013 **France** **Prospective study**	NA	302 consecutive stroke patients admitted to an emergency department with acute ischemic stroke who received thrombolysis.	Patients were categorized based on type of pre-notification used: high-level (call to EMS and EMS neurologist), low-level (call to EMS but not EMS neurologist), and no pre-notification.	**Primary outcomes:** Time from stroke onset-to-hospital admission, admission-to-imaging time, imaging-to-needle time, door-to-needle time, and onset-to-needle time.	63% (n=191) of patients had a high-level of pre-notification, whereas 18% (n=55) had a low-level and 19% (n=56) had no pre-notification. Median time from admission-to-imaging was 27 min (IQR 14-35) for patients with high-level pre-notification, compared to 35 min (IQR 17-54) and 36 min (IQR 30-58) for those with low-level or no pre-notification, respectively (p<0.001). Pre-notification was associated with a significantly shorter door-to-needle time (high-level=49 min, low-level=57 min, no pre-notification=63 min; p<0.01) and onset-to-needle time (high-level=140 min, low-level=155 min, no pre-notification=182 min; p<0.001). Pre-notification was not associated with a significant reduction in stroke onset-to-admission time or

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					imaging-to-needle time.
Dalloz et al. 2012 **France** **Systematic Review**	NA	10 studies, published from January 2000 to May 2010, were identified, of which 5 reported rates of thrombolysis in a setting with a pre-hospital stroke code system, 4 reported rates in a setting with an in-hospital system and 3 in a setting with no stroke code system in place.	Studies were classified as having data derived from a hospital setting that had: 1. Pre-hospital stroke code 2. In-hospital stroke code or 3. No stroke code. Rates of thrombolysis between hospital settings were compared.	**Primary outcomes:** Rate of thrombolysis and door to needle time.	**Thrombolysis:** The odds of treatment with thrombolysis were increased significantly for patients from hospitals with pre-hospital stroke codes compared to those with no stroke code (OR=5.43, 95% CI: 3.84-7.73, p<0.001). The odds of treatment were significantly higher for patients treated in hospital with pre-hospital stroke code compared with in-hospital stroke code (OR=1.97, 95% CI: 1.53-2.54, p<0.001). The odds of treatment were significantly higher for patients treated in hospital with in-hospital stroke code compared with no stroke code (OR= 2.75, 95% CI: 1.92-3.97, p<0.001). Door to needle times were longer (>90 minutes) in hospitals that did not have a pre-hospital or in-hospital stroke codes.
Berglund et al. 2012 **Sweden** **RCT** ***Hyper Acute STroke Alarm (HASTA) Study***	CA: ☑ Blinding: Patient ☒ Assessor ☒ ITT: ☒	943 patients, aged 18-85 years, previously independent in ADLs, with a suspected stroke within 6 hours of symptom onset. Mean age was 71 years.	Patients were randomized to an intervention group (n=332) and received an upgraded priority level (Level “1”) by the Emergency Medical Communications Centre (EMCC) or to a control group (n=335) and received the standard priority level (Level “2”). In cases when a stroke was not initially suspected by the EMCC, EMS personnel randomized patients on scene to receive either priority 1 or 2 level notification.	**Primary outcome:** Time between all stages of the process between call to EMS and call to hospital stroke unit. **Secondary outcome:** Rate of thrombolysis.	**Time delays:** Patients classified as Priority Level 1 by EMCC (intervention group) experienced fewer delays in the median time between the call to EMS and dispatch of EMS (5 vs. 8 minutes, p<0.001), between ambulance dispatch to arrival on scene (9 vs. 15 minutes, p<0.001), and between pre-hospital call to hospital arrival (42 vs. 55 minutes, p<0.001) compared to patients classified as Priority Level 2 (control group). **Rate of thrombolysis:** Patients classified as Priority Level 1 by EMCC received thrombolysis more often than those classified as priority level 2 (24% vs. 10%, p<0.001) and a greater number arrived to the stroke unit within 3 hours of symptom onset (61% vs. 46%, p=0.008).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			Level 1 notification required an immediate ambulance dispatch with prenotification to the ED. Priority 2 notification required ambulance arrival on scene within 30 minutes, unless the ambulance was required by another call.		
O'Brien et al. 2012 **Australia** **Prospective study**	NA	115 patients who presented to a single institution within 24 hours of onset of ischaemic stroke.	Comparison of the number of eligible patients treated with t-PA, in the 6 months prior to the establishment of the FASTER (Face, Arm, Speech, Time, Emergency Response) protocol, designed for the rapid identification and referral of eligible patients for treatment with t-PA. The protocol included screening by EMS workers, hospital by-pass, and pre-notification.	**Primary outcome:** Number of patients who received t-PA **Secondary outcomes:** Time (minutes) from symptom onset to hospital arrival, ED door-to-CT scan, ED door-to-needle (t-PA administration) and ED door-to-Stroke Unit.	In the first 6 months of its implementation, 22 patients (19%) were treated with t-PA. This proportion was significantly higher than 7 of 63 (7%) patients treated during the 6 months prior to FASTER (p=0.03). There were 42 FASTER referrals of which 21 (50%) were treated with t-PA. Compared with all patients treated with t-PA during the previous 3 years, all secondary outcomes (mean minutes) were significantly shorter compared with the times recorded during the FASTER period.
Gladstone et al. 2009 **Canada** **Retrospective study**	NA	Patients with suspected stroke (unilateral weakness or drift, facial droop or slurred speech and the ability to be transported to hospital within 2 hours of symptom onset), who presented to the ED of a regional stroke centre	Comparison of process indicators during the 4 months before (n=217) and the 4 months after (n=290) the implementation of a new stroke triage protocol, which included paramedic prenotification, a hospital bypass protocol and a hospital code "stroke" paging system.	**Primary outcomes:** Number of patients transported to hospital within 2.5 hours of symptom onset, arrival times and t-PA use	The number of patients arriving to the ED with suspected stroke increased significantly after the new triage system (48.6% vs. 30.4%, p<0.0001). The number of patients with ischemic stroke who received t-PA increased significantly after the new triage system (23.4% vs. 9.5%, p<0.01). The median stroke onset-to-needle time (t-PA patients) decreased significantly after the new triage system (195 vs. 141 minutes, p=0.003). The median stroke onset-to-ED arrival time (t-PA patients) did not differ significantly after the new triage system (46 vs. 63 minutes, p=0.83).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					The median ED arrival-to-needle time (t-PA patients) decreased significantly after the new triage system (128 vs. 83 minutes, p=0.007).
Kim et al. 2009 **Korea** **Retrospective study**	NA	91 patients treated with t-PA following acute stroke. Mean age was 63 years, 66% were male. Median NIHSS score was 13.	Comparison of process indicators and outcomes before (Jan-Oct 2006, n=44) and after Oct 2006-Nov 2006, (n=47) the implementation of a new hospital prenotification system for patients who were candidates for treatment with t-PA.	**Primary outcome:** Door-to-needle time **Secondary outcomes:** Good outcome at 90 days (mRS 0-2), symptomatic ICH	Before the implementation 44/678 (6%) patients were treated with t-PA compared with 47/328 (14.3%). In total, 30 patients were treated with prenotification compared with 61 without. The mean time from symptom onset to ED arrival was significantly *longer* in the prenotification group (121.5 vs. 74.7 minutes, p<0.01), as was the mean time from symptom onset to-needle time (150.4 vs. 122.6 minutes, p<0.01); however, the mean door-to-needle time was significantly shorter (28.9 vs. 47.7 minutes, p<0.01). There was no significant difference between groups in the number of patients with a good outcome at 90 days (60.6% vs. 53.3%, p=0.62), or the number of sICHs (10% vs. 4.9%, p=0.063)

Mobile Stroke Units

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Kunz et al. 2016 **Germany** **Retrospective study**	NA	Patients who were living independently prior to stroke, who received thrombolysis following acute stroke. Mean age was 70.5 years, 42% male, Median baseline NIHSS score was 8.	The outcomes of patients who received thrombolysis therapy using the mobile stroke unit, STEMO from 2011-2015 (n=505) were compared with patients who received thrombolysis but arrived to hospital via EMS (n=353). Patients from the EMS group were only	**Primary outcome:** Excellent functional outcome at 3 months (mRS 0-1) **Secondary outcomes:** Proportion of patients living without severe disability, or able to ambulate independently (mRS 0-3) at 3 months, 3-month mortality **Safety outcomes:**	The median time from stroke onset to thrombolysis was significantly shorter in the STEMO group (73 vs. 115 minutes, p<0.0005. A significantly higher proportion of patients in the STEMO group were treated ≤ 90 minutes of stroke (62% vs. 35%, p<0.0005). There was no significant difference in the number of patients who achieved an excellent outcome at 3 months (53% STEMO vs. 47% conventional, p=0.14).

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			included if they were treated during the hours that STEMO operated (0700-2300 h)	Intracranial hemorrhage, 7-day mortality	A significantly higher proportion of patients in the STEMO group were living without severe disability at 3 months (83% vs. 74%, p=0.004). 3-month mortality was significantly lower in the STEMO group (6% vs. 10%, p=0.022). There were no significant differences in the safety outcomes between the 2 groups (sICH 3% vs. 5%, p=0.27 and 7-day mortality 2% vs. 4%, p=0.23) Adjusting for baseline characteristics, STEMO was an independent predictor of living without severe disability at 3 months (OR=1.86, 95% CI 1.20-2.88, p+0.006), but was not an independent predictor of the primary outcome (OR=1.40, 95% CI 1.00-1.97, p=0.052).
Ebinger et al. 2014 ***PHANTOM-S*** **Germany** **Open-label RCT**	CA: ☒ Blinding patient: ☒ assessor: ☒ ITT: ☒	7,986 patients, who lived within 16 minutes' travel time from the fire station were STEMO was based, within symptom onset <4 hours. Treated at one of 14 hospitals. Mean age was 74 years, 44.5% were male.	Patients were randomized to receive response from a Stroke Emergency Mobile (STEMO) ambulance, equipped with a CT scanner, point-of-care-lab and a specialized pre-hospital stroke team including a paramedic, neurologist and neuroradiologist or to routine care (n=2,969) on alternating weeks.	**Primary outcome:** Time from alarm to t-PA treatment **Secondary outcomes:** Thrombolysis rate, in-hospital mortality, symptomatic ICH, adverse events	Of 3,213 patients who suffered a stroke during an on- STEMO week, STEMO was deployed in 1,804 cases. In most of the cases when STEMO was not deployed, it was already in use and was not available. Of the patients with ischemic stroke, t-PA was used in 32.6% of STEMO deployment cases, 29% during STEMO weeks, and 21.1% during control weeks. Mean alarm to treatment time was significantly shorter in the STEMO deployed group compared with the control weeks (51.8 vs. 76.3 min, p<0.001). The proportions of patients treated with t-PA within 90 minutes of stroke were significantly higher when STEMO was deployed (58%), compared with 48% during STEMO weeks (i.e., STEMO not deployed) and 37% during control weeks. There were no significant differences among groups in hospital mortality, sICH or LOS.
Walter et al. 2012 **Germany**	CA: ☑ Blinding	100 patients 18-80 years with ≥1 stroke symptoms using the modified	Patients were randomized to a mobile stroke unit (MSU) group	**Primary outcome:** Time from alarm to treatment decision	The trial was stopped early after interim analysis, which demonstrated pre-specified superiority of the MSU. 200 patients were planned.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
RCT	patient: ☒ assessor: ☒ ITT: ☑	ROSIER criteria, beginning within the previous 2-5 hours. Median age was 71 years, 62% were male. Median baseline NIHSS scores were 5 (MSU) and 6 (control)	(n=53) or a control group (n=47). The MSU response consisted of a paramedic, neurologist and neuroradiologist and the ambulance was equipped with a portable CT scanner, a telemedicine system and a point-of-care laboratory. Patients in the control group received optimised conventional stroke management in hospital, which included point-of-care laboratory	**Secondary outcomes:** Number of patients treated with t-PA, time from alarm to t-PA, number of patients with t-PA or intra-arterial recanalization, time from alarm to t-PA or to intra-arterial recanalization. NIHSS, BI and mRS scores at days 1 and 7.	29 MSU patients (55%) and 25 (53%) control patients were diagnosed with ischemic stroke. Median time from alarm to treatment decision was significantly shorter in the MSU group (35 vs. 76 min, p<0.0001). Median time from stroke onset to treatment decision was significantly shorter in the MSU group (56 vs. 104 min, p<0.0001). Similar proportions of patients were treated with t-PA (23% vs. 17%, p=0.30). Median times from alarm and symptom onset to treatment with t-PA were significantly shorter in the MSU group (38 vs. 73 min, p<0.0001, and 73 vs. 153, p=0.0011, respectively). 23% of patients in both groups were treated with t-PA or endovascular therapy. Median times from alarm and symptom onset to therapy were significantly shorter in the MSU group. There were no significant differences in neurological outcomes between groups, assessed using NIHSS, BI or mRS at either day 1 or 7. Survival at day 7 was 89% (MSU) and 96% (control). CT scanning was unavailable for 8 patients in the MSU group due to technical problems.

Prehospital Screening Scales to Identify Stroke & Large Vessel Occlusions

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Smith et al. 2018	NA	36 studies evaluating the accuracy of LVO prediction	Forest plots were produced, stratified by	**Primary outcome:** Test characteristics of LVO	In 4 studies the prediction scales were applied in the pre-hospital setting (i.e., EMS). In the

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Canada/US/UK **Systematic review & meta-analysis**		scales in patients with suspected stroke or presumed acute ischemic stroke in pre-hospital or emergency department settings.	LVO prediction instrument and population (suspected stroke or ischemic stroke), when results were available for >1 study. When sufficient data were available for a given LVO prediction instrument, summary receiver-operating characteristics (ROC) curves were produced.	prediction scales Sensitivity (SN), specificity (SP), area under ROC (AUC)	remaining studies, the scales were used in emergency departments, in mixed settings or the setting was not stated. The most commonly used prediction scales included NIHSS, the Cincinnati Prehospital Stroke Severity Scale, Rapid Arterial oCclusion Evaluation, The Los Angeles Motor Scale and the 3-item stroke scale. In pooled ROC analysis, using the NIHSS in patients with suspected stroke, and a cut-off of 6,8 and 10, the SNs were 0.80, 0.73. and 0.64, respectively. The associated SPs were 0.72, 0.79 and 0.84.7 studies included. In pooled ROC analysis, using the NIHSS in patients with ischemic stroke, and a cut-off of 6,8 and 10, the SNs were 0.87, 0.81 and 0.73, respectively. The associated SPs were 0.53, 0.63 and 0.74. 13 studies included. In pooled ROC analysis, using the CPSSS in patients with ischemic stroke, the SN and SP ranged from 0.95 to 0.69 (cut-off of 0) to 0.15 to 0.93 (cut-off of 4). 6 studies included. AUC for all studies (where reported), using various cut points ranged from 0.65 to 0.85. Given a pre-test prevalence of LVO of 20%, the post-test probability of LVO ranged from 40-50% in suspected stroke using 4 different scales and cut-points. Given a pre-test prevalence of LVO of 35%, the post-test probability of LVO ranged from 50-60% in ischemic stroke using NIHSS with cut-points of 6, 8and 10. The authors concluded that no scale had both high sensitivity and specificity to determine the

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
					presence vs. absence of LVO, and that in clinical practice that the probability of LVO given a negative test could still be ≥10%.
Noorian et al. 2018 **USA** **Prospective study**	NA	94 patients transported by EMS with suspected stroke who were enrolled in the FAST-MAG trial and in whom an MRA or CTA was obtained within 6 hours of ED arrival and before intravenous tPA or endovascular thrombectomy. Mean age was 70 years, 51% were men.	The performance of the Los Angeles Motor Scale (LAMS) administered by paramedics in the prehospital setting was assessed in identifying 1) LVOs among all patients with ischemic stroke and 2) Comprehensive Stroke Centers (CSC) - appropriate patients (i.e. those with ischemic stroke, ICH or LVO) among all suspected stroke patients. The LAMS administered post arrival in the Emergency Department was compared concurrently with 6 other scales proposed for paramedic use including the Cincinnati Stroke Triage Assessment Tool (C-STAT; formerly CPSSS), Field Assessment Stroke Triage for Emergency Destination, Prehospital Acute Stroke Severity scale, Rapid Arterial Occlusion Evaluation (RACE) scale and the Vision-Aphasia Neglect (VAN) scale; and 2 scales suggested for	**Primary outcomes:** Test characteristics of scales	Final diagnoses were ischemic stroke (76%), ICH (19%) and stroke mimics (5%). There were 45 (48%) of LVOs, 5 (5%) medium vessel occlusions and 21 (22%) with no vessel occlusions. The test characteristics of LAMS ≥4 to identify LVO among patients with ischemic stroke were: Sensitivity 0.76; specificity 0.65 Positive predictive value (PPV) 0.79 Negative predictive value (NPV) 0.61 Accuracy 0.72 The test characteristics of LAMS ≥4 to identify patients suitable for transport to a CSC were: Sensitivity 0.73; specificity 0.71 Positive predictive value (PPV) 0.84 Negative predictive value (NPV) 0.56 Accuracy 0.72. For identifying LVOs among those with cerebral ischemia, all scales showed fair to moderate performance (accuracies ranging from 0.62–0.70). The 4 highest accuracy point estimates were for the LAMS (0.70), the C-STAT (0.68), the Prehospital Acute Stroke Severity scale (0.68), and the full NIHSS cutoff at ≥7 (0.68). The 2 lowest accuracies were for the 3i-SS (0.62) and the VAN (0.63). For identifying CSC-appropriate patients among all suspected stroke transports, the scales showed performance ranging from poor to moderate (accuracies ranging from 0.56–0.73). The 4 highest accuracy point estimates were for the LAMS (0.73) and the full NIHSS cutoff at ≥7

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
			use in the ED (NIHSS with cut-points of ≥ 7 and 10, and the 3-item Stroke scale (3i-SS)		(0.73), RACE (0.66), and VAN (0.66). The two lowest accuracy estimates were for the 3i-SS (0.56) and the C-STAT (0.62).
Purrucker et al. 2017 **Germany** **Prospective/ Retrospective**	NA	326 EMS personnel, paramedics, ER physicians and stroke physicians were invited to rate the suitability of each NIHSS item for its suitability for prehospital use on a 6-item scale, ranging from 0 (most suitable) to 5 (most unsuitable). Items which scored a 0 or 1 were included into a newly-formed shortened NIHSS-EMS (sNIHSS-EMS) scale.	Test characteristics of the new scale were calculated regarding performance in stroke recognition and prediction of acute LVO, using two clinical cohorts. Cohort 1 included 689 consecutive patients with 'suspected acute CNS disorder' admitted to an ER. Cohort 2 (LVO validation cohort) included 741 consecutively-admitted patients with ischemic stroke. The sNIHSS-EMS was evaluated against other LVO prediction scales (3-item Stroke Scale, Prehospital Acute Stroke Severity Scale, Cincinnati Prehospital Stroke Severity Scale etc).	**Primary outcomes:** Sensitivity (SN), specificity (SP), positive predictive value (PPV), negative predictive value (NPV), area under ROC (AUC)	9 NIHSS items formed the sNIHSS-EMS scale: LOC (1a), facial palsy (4). Motor arm-left (5), motor arm-right (5), motor leg-left (6), motor leg-right (6), sensory (8), best language (9), dysarthria (10). Total possible scores ranged from 0-29. *Stroke recognition* 29% of patients admitted to the ER with suspected stroke (cohort 1) had a discharge diagnosis of stroke. Using an optimal sNIHSS-EMS cut-off score of ≥1, the test characteristics were: SN 90.5%, 95% CI 85.6 to 94.2%, SP 51.5%, 95% CI 47.0 to 56.1%, PPV 43.3%, 95% CI 38.5 to 48.2%, NPV 93.0%, 95% CI 89.3 to 95.6%. *LVO Prediction* 39% of patients in cohort 2 had a LVO. Using an optimal sNIHSS-EMS cut-off score of ≥6, the test characteristics were: SN 70.3%, 95% CI 64.7 to 75.5%, SP 80.7%, 95% CI 76.8 to 84.3%, PPV 70.1%, 95% CI 64.5 to 75.32%, NPV 80.9%, 95% CI 76.9 to 84.4%, accuracy 76.7%, AUC 0.81, 95% CI 0.78 to 0.84. The AUCs for other prediction scales, calculated using cohort 2 patients were not-significantly different from the sNIHSS-EMS result.
Kesinger et al. 2015 **USA** **Retrospective study**	NA	305 patients, transported to a comprehensive stroke centre by helicopter EMS (HEMS) with ischemic stroke, who had a NIHSS scored completed by both HEMS and the stroke team. Median age was 70	NIHSS scores obtained by HEMS and stroke team were compared. NIHSS scores were also categorized into 3 clinical groups, based	**Primary outcomes:** Agreement between raters, test characteristics of NIHSS categories to predict LVO: Sensitivity (SN), specificity (SP), positive predictive value	The median HEMS and stroke team NIHSS scores were 8 (4–15), and (4–15), respectively. Spearman correlation between scoring was 0.838 ($p<0.001$). 68.9% of patients had a LVO.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
		years, 52% were women.	on their ability to predict the likelihood of intervention for LVO: low (NIHSS≤4), intermediate (NIHSS≥4 and <12), and high (NIHSS≥12)	(PPV), negative predictive value (NPV), area under ROC (AUC	Agreement between raters in clinical group assignment was 72.1% (κ=0.571). Interclass correlation was 0.879 (95% CI 0.849–0.904). 5.2% of patients were under triaged by HEMS (i.e classified as category 1, instead of 2) At a cut-off score of NIHSS≥12, HEMS had a PPV of 80.5% (SN 51.9%; SP 87.4%), and the stroke team had a PPV of 88.5% (SN 48.6%; SP 93.7%). HEMSs and the stroke team demonstrated similar performance in their ability to predict LVO (AUC 0.768 and 0.770, respectively).
Nor et al. 2004 **UK** **Prospective study**	NA	278 persons with suspected stroke or TIA who were referred to an acute stroke unit by paramedics through the Rapid Ambulance Protocol.	The observed agreement between paramedics and stroke neurologists/trainee neurologist for each component of FAST sign in confirmed stroke cases, was estimated	**Primary outcome:** Agreement between raters	217 (78%) patients had a confirmed stroke or TIA. Trainee neurologist performed 95% of FAST evaluations. FAST signs were assessed by the stroke neurologist a median of 18 hours after paramedic assessment. Admitting physician findings in all patients with confirmed stroke indicated that 87% had arm weakness, 62% had facial weakness, and 72% had speech disturbance. Agreement between raters Facial weakness, 68% vs. 70% (κ.=0.49, 95% CI 0.36-0.62) Arm weakness, 96% vs. 95% (κ=0.77, 95% CI 0.55- 0.99) Speech disturbance, 79% vs. 77% (κ=0.69, 95% CI 0.56- 0.82)

Development of Prehospital Stroke Screening Scales to Identify Large Vessel Occlusions

Author/ Assessment Tool	Purpose of the tool Details of the validation study	Items and Scoring	Results of validation study
Lima et al. 2016 **Field Assessment Stroke Triage for Emergency Destination (FAST-ED)**	**Purpose:** To identify patients with emergent large vessel occlusion. Intended for use by EMS. **Sample:** 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.	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	Diagnostic standard: CTA Large vessel occlusion was present in 240 patients (33%) 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
Teleb et al. 2016 **Vision, Aphasia, and Neglect (VAN)**	**Purpose:** Prediction of emergent large vessel occlusion. Piloted by trained ED nurses. **Sample:** 62 acute stroke codes at a single facility	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 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	Diagnostic standard: CTA Performance was also compared with NIHSS ≥6 Large vessel occlusion was present in 19 patients (30.6%) 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
Hastrup et al. 2016 **Prehospital Acute Stroke**	**Purpose**: Prediction of emergent large vessel occlusion. Intended for use by EMS. **Sample**: 3,127 patients included in the	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	Diagnostic standard: CTA/MRA Arterial occlusion was detected in 35% of patients A cut-point of ≥2 on the PASS had the best predictive value:

Author/ Assessment Tool	Purpose of the tool Details of the validation study	Items and Scoring	Results of validation study
Severity Scale (PASS)	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	point 3. Arm weakness (NIHSS item arm weakness >0) 1 point Total possible score: 3	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
Katz et al. 2015 **Cincinnati Prehospital Stroke Severity Scale (CPSSS)**	**Purpose**: Prediction of severe acute ischemic stroke (NIHSS ≥15) and proximal large vessel occlusion (LVO). Intended for use by EMS. **Sample**: Derivation cohort-624 patients with mild to severe stroke from 2 NINDS t-PA trials. Validation cohort-650 patients from the IMS-III trial	3 NIHSS items: 1. Conjugate gaze deviation (≥1 on NIHSS item for gaze) 2 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	Diagnostic standard: CTA In the validation cohort, 222 (34%) patients had LVO **Severe stroke** AUC: 0.89 A cut point of ≥2 had the best predictive value for severe stroke 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 **LVO** For the detection of LVO (using the validation cohort-220 with confirmed LVO) and a cut point of ≥2 Sensitivity: 83% Specificity: 40% + LR/-LR: 1.4/0.4
Pérez de la Ossa et al. 2014 **Rapid Arterial oCclusion Evaluation**	**Purpose**: Prediction of acute stroke and large vessel occlusion (LVO). For use by EMS **Sample**: Derivation cohort-654 patients with acute stroke or stroke mimic for	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,	Diagnostic standard: LVO was detected by transcranial Doppler, CT or MRA. 178 patients (27%) had a LVO in derivation cohort vs. 76 (21.3%) in the validation cohort. In the derivation cohort, there was a strong

Author/ Assessment Tool	Purpose of the tool Details of the validation study	Items and Scoring	Results of validation study
Scale (RACE)	whom a stroke code had been activated by EMS or a community hospital. Validation cohort-357 patients transferred by EMS to a stroke centre **Scale tested by:** EMS providers during validation phase	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	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
Nazliel et al. 2008 **The Los Angeles Motor Scale (LAMS)**	**Purpose**: Prediction of persisting large vessel occlusion (PLVO) in acute ischemic stroke. For use by EMS and Emergency Department use **Sample**: 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	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	Diagnostic standard: MRA/CTA, or catheter angiography PLVO was detected in 74 (62%) patients 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
Singer et al. 2005 **3-Item Stroke Scale (3ISS)**	**Purpose**: Prediction of stroke severity and MCA occlusion. **Patients:** 180 patients presenting to a stroke unit in 2002 with symptoms of stroke within ≤6 hours (28 patients had ICH). **Scale tested by**: Stroke neurologists	3 items: Disturbance of consciousness (no= 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	Diagnostic standard: MRI/MRA/CT 27 patients (15%) had distal ICA, M1 or M2 occlusions A cut point of ≥4 had the best predictive value for detecting MCA occlusions Sensitivity: 67% 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

References

Abboud ME, Band R, Jia J, et al. Recognition of Stroke by EMS is associated with improvement in emergency department quality measures. *Prehosp Emerg Care* 2016*;* 20(6):729-736.

Berglund, A., Svensson, L., Sjostrand, C., von, A. M., von, E. M., Wahlgren, N. et al. Higher prehospital priority level of stroke improves thrombolysis frequency and time to stroke unit: the Hyper Acute STroke Alarm (HASTA) study. *Stroke* 2012; 43: 2666-2670.

Caceres JA, Adil MM, Jdhav V, et al. Diagnosis of stroke by emergency medical dispatchers and its impact on the prehospital care of patients. *J Stroke Cerebrovas Dis* 2013;22:e610-e614.

Casolla B, Bodenant M, Girot M, et al. Intra-hospital delays in stroke patients treated with rt-PA: impact of preadmission notification. *J Neurol* 2013;620: 635-639

Chenkin, J., Gladstone, D. J., Verbeek, P. R., Lindsay, P., Fang, J., Black, S. E. et al. Predictive value of the Ontario prehospital stroke screening tool for the identification of patients with acute stroke. *Prehosp Emerg Care* 2009;13:153-159.

Dalloz, M. A., Bottin, L., Muresan, I. P., Favrole, P., Foulon, S., Levy, P. et al. Thrombolysis rate and impact of a stroke code: A French hospital experience and a systematic review. *J Neurol Sci* 2012;314:120-125.

Ebinger M, Winter B, Wendt M, Weber JE, Waldschmidt C, Rozanski M et al. Effect of the use of ambulance-based thrombolysis on time to thrombolysis in acute ischemic stroke: a randomized clinical trial. *JAMA* 2014; 311(16):1622-1631.

Gladstone DJ, Rodan LH, Sahlas DJ, et al. A citywide prehospital protocol increases access to stroke thrombolysis in Toronto. *Stroke 2009*;40(12):3841-3844.

Hastrup S, Damgaard D, Johnsen SP, Andersen G. Prehospital Acute Stroke Severity Scale to Predict Large Artery Occlusion: Design and comparison with other scales. *Stroke* 2016;47(7):1772-1776.

Hsieh MJ, Tang SC, Chiang WC, Tsai LK, Jeng JS, Ma MH. Effect of prehospital notification on acute stroke care: a multicenter study. *Scand J Trauma Resusc Emerg Med. 2016*;24(1):57.

Katz BS, McMullan JT, Sucharew H, Adeoye O, Broderick JP. Design and validation of a prehospital scale to predict stroke severity: Cincinnati Prehospital Stroke Severity Scale. Stroke. 2015;46(6):1508-1512.

Kesinger MR, Sequeira DJ, Buffalini S, Guyette FX. Comparing National Institutes of Health Stroke Scale among a stroke team and helicopter emergency medical service providers. *Stroke.* 2015;46:575–578

Kim DH, Nah HW, Park HS, et al. Impact of prehospital intervention on delay time to thrombolytic therapy in a stroke center with a systemized stroke code program. *J Stroke Cerebrovasc Dis. 201*6;25(7):1665-70.

Kim SK, Lee SY, Bae HJ, et al. Pre-hospital notification reduced the door-to-needle time for iv t-PA in acute ischaemic stroke. *Eur J Neurol 2009*;16(12):1331-1335**.**

Kunz A, Ebinger M, Geisler F, et al. Functional outcomes of pre-hospital thrombolysis in a mobile stroke treatment unit compared with conventional care: an observational registry study. *Lancet Neurol.* 2016; 15(10):1035-43

Lima FO, Silva GS, Furie KL, et al. Field Assessment Stroke Triage for Emergency Destination: A Simple and Accurate Prehospital Scale to Detect Large Vessel Occlusion Strokes. *Stroke 2016*;47(8):1997-2002.

Lin CB, Peterson ED, Smith EE, et al. Emergency medical service hospital prenotification is associated with improved evaluation and treatment of acute ischemic stroke. *Circ Cardiovasc Qual Outcome*s 2012;5:514-522.

McKinney, J. S., Mylavarapu, K., Lane, J., Roberts, V., Ohman-Strickland, P., & Merlin, M. A. Hospital prenotification of stroke patients by emergency medical services improves stroke time targets. *J Stroke Cerebrovasc Dis* 2013;22:113-118.

Nazliel B, Starkman S, Liebeskind DS, et al. A brief prehospital stroke severity scale identifies ischemic stroke patients harboring persisting large arterial occlusions. *Stroke* 2008;39(8):2264-2267.

Noorian AR, Sanossian N, Shkirkova K, Liebeskind DS, Eckstein M, Stratton SJ, Pratt FD, Conwit R, Chatfield F, Sharma LK, Restrepo L. Los Angeles Motor Scale to Identify Large Vessel Occlusion: Prehospital Validation and Comparison with Other Screens. *Stroke.* 2018;49(3):565-72.

Nor AM, McAllister C, Louw SJ, Dyker AG, Davis M, Jenkinson D, Ford GA. Agreement between ambulance paramedic-and physician-recorded neurological signs with Face Arm Speech Test (FAST) in acute stroke patients. *Stroke* 2004;35(6):1355-9.

O'Brien W, Crimmins D, Donaldson W, Risti R, Clarke TA, Whyte S, et al. FASTER (Face, Arm, Speech, Time, Emergency Response): experience of Central Coast Stroke Services implementation of a pre-hospital notification system for expedient management of acute stroke. *J Clin Neurosci* 2012;19(2):241-5.

Perez de la Ossa N, Carrera D, Gorchs M, et al. Design and validation of a prehospital stroke scale to predict large arterial occlusion: the rapid arterial occlusion evaluation scale *Stroke.* 2014;45(1):87-91.

Purrucker JC, Härtig F, Richter H, et al. Design and validation of a clinical scale for prehospital stroke recognition, severity grading and prediction of large vessel occlusion: the shortened NIH Stroke Scale for emergency medical services. *BMJ Open* 2017;7:e016893.

Patel, M. D., Rose, K. M., O'Brien, E. C., & Rosamond, W. D. Prehospital notification by emergency medical services reduces delays in stroke evaluation: findings from the North Carolina stroke care collaborative. *Stroke* 2011;42: 2263-2268.

Singer OC, Dvorak F, du Mesnil de Rochemont R, Lanfermann H, Sitzer M, Neumann-Haefelin T. A simple 3-item stroke scale: comparison with the National Institutes of Health Stroke Scale and prediction of middle cerebral artery occlusion. *Stroke 2005*;36(4):773-776.

Smith EE, Kent DM, Bulsara KR, Leung LY, Lichtman JH, Reeves MJ, Towfighi A, Whiteley WN, Zahuranec DB; on behalf of the American Heart Association Stroke Council. Accuracy of prediction instruments for diagnosing large vessel occlusion in individuals with suspected stroke: a systematic review for the 2018 guidelines for the early management of patients with acute ischemic stroke. *Stroke*. 2018;49(3):e111-e122.

Teleb MS, Ver Hage A, Carter J, Jayaraman MV, McTaggart RA. Stroke vision, aphasia, neglect (VAN) assessment-a novel emergent large vessel occlusion screening tool: pilot study and comparison with current clinical severity indices. *J Neurointerv Surg 2017;9(2):122-126*.

Watkins CL, Leathley MJ, Jones SP, et al. Training emergency services' dispatchers to recognise stroke: an interrupted time-series analysis. *BMC Health Services Res* 2013;13:318-327.

Walter S, Kostopoulos P, Haass A, Keller I, Lesmeister M, Schlechtriemen T et al. Diagnosis and treatment of patients with stroke in a mobile stroke unit versus in hospital: a randomised controlled trial. *Lancet Neurol 2012*; 11(5):397-404.