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RESEARCH

Comparison of two pre-hospital stroke scales to detect large vessel occlusion strokes in Australia: A prospective observational study

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Abstract

Aims: Hunter-8 and ACT-FAST are two stroke scales used in Australia for the pre-hospital identification of large vessel occlusion (LVO) stroke, but they have not previously been compared. Moreover, their use in identifying distal arterial occlusions has not previously been assessed. We therefore aimed to describe the area under the receiver operating curve (AUC) of Hunter-8 versus ACT-FAST for the detection of LVO stroke.

Methods: Both scales were performed on consecutive patients presenting with stroke-like symptoms within 24 hours of symptom onset presenting to the emergency department at a tertiary referral hospital between June 2018 and January 2019. The AUC of Hunter-8 and ACT-FAST was calculated for the detection of LVO using different definitions (classic LVO – proximal segment of the middle cerebral artery (MCA-M1), terminal internal carotid artery (T-ICA) or tandem occlusions – and extended LVO – classic LVO plus proximal MCA-M2 and basilar occlusions).

Results: Of 126 suspected stroke patients, there were 24 classic LVO and 34 extended LVO. For detection of classic LVO, Hunter-8 had an AUC of 0.79 and ACT-FAST had an AUC of 0.77. For extended LVO, the AUC was 0.71 and 0.70 respectively. The AUC for the subgroup of patients with MCA-M2 and basilar occlusions was 0.42 and 0.43 respectively.

Conclusion: Both scales represent a significant opportunity to identify patients with proven potential benefit from thrombectomy (classic LVO), however M2 and basilar occlusions may be more challenging to identify with these scales.

Keywords
pre-hospital; ambulance; stroke; large vessel occlusion; thrombectomy

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INTRODUCTION

Large vessel occlusion (LVO) of the proximal intracranial vessels accounts for one third of acute ischemic stroke presentations.(1) They have an associated high mortality and morbidity compared to non-LVO strokes.(2) Randomised clinical trials (RCTs) published in 2015 showed efficacy of endovascular thrombectomy (EVT) over standard care in patients with proximal occlusions of the anterior circulation within six hours of symptom onset.(3–7) In 2018, it was shown that in those patients selected using advanced neuroimaging, the window of treatment could be extended up to 24 hours from time last seen well.(8,9)

These findings have brought logistic challenges for healthcare services.(10) EVT capacity is typically found at a relatively small number of comprehensive stroke centres (CSC). Initial assessment at a peripheral hospital, with subsequent patient transfer may result in substantial delays in treatment times. One way to avoid delays and to alleviate the burden on ambulance services and CSC, is to identify patients with LVO pre-hospital in order to transport these patients directly to the CSC.

Both Hunter-8 and ACT-FAST are stroke scales developed and implemented in Australia for detection of LVO.(10,11) Hunter-8 is a shortened version of the National Institutes of Health Stroke Scale (NIHSS), with eight items; a score ≥ 8 identifies a classic LVO (defined as proximal segment of the middle cerebral artery (MCA-M1), terminal internal carotid artery (T-ICA) or combined intra- and extra-cranial tandem occlusions). A validation study indicated reasonably high accuracy with an area under the receiver operating characteristic curve (AUC) of 0.82.(10) In comparison, ACT-FAST is a 3-step tool with a published AUC of 0.94 for classic LVO if all three steps are positive.(11) These two scales are currently used in the Australian pre-hospital setting but have not previously been compared. We therefore aimed to describe the sensitivity, specificity and AUC of Hunter-8 versus ACT-FAST for the detection of classic LVO.

Furthermore, there is increasing use of EVT for more distal occlusions not included in those initial validations, especially for MCA-M2 proximal segments and for basilar artery occlusions.(12) We were therefore interested in whether the stroke scales also identify extended LVOs (defined as classic LVO, plus proximal MCA-M2 segment or basilar occlusions), and our secondary aim was to describe the sensitivity, specificity and AUC of Hunter-8 and ACT-FAST for extended LVO as well as the subgroup of patients with proximal MCA-M2 segment and basilar occlusions.

METHODS

Population and data collection

A prospective observational study of consecutive patients presenting to the emergency department of a tertiary referral hospital with suspected stroke in the June 2018–January 2019 period was conducted. We included patients who presented with symptoms of stroke within 24 hours from time last seen well and underwent acute stroke imaging with brain non-contrast computed tomography (NCCT), computed tomography angiography (CTA) and computed tomography perfusion scan (CTP). The Hunter-8 and ACT-FAST scores were performed by one member of the stroke team on arrival to the emergency department, prior to brain imaging. Further data collected included baseline demographics, NIHSS on presentation, brain imaging characteristics (vessel status and perfusion lesion volume on CTP), reperfusion treatment and final diagnosis. Confirmed ischemic stroke was defined as those with confirmed brain infarct on initial CT, follow-up CT or follow up magnetic resonance imaging (MRI). Patients were diagnosed with transient ischemic attack (TIA) if they had no infarction on imaging and their clinical history was consistent with the diagnosis of TIA as deemed by the treating neurologist. Patients were diagnosed as mimics if they had no infarction on imaging and their clinical history was consistent with the diagnosis of a mimic condition as deemed by the treating neurologist. Patients were classed as classic LVO if they had an arterial occlusion of the MCA-M1, T-ICA or had a tandem occlusion. Patients were classed as extended LVO if they had an arterial occlusion of the MCA-M1, T-ICA, tandem occlusion, proximal M2 segment of MCA or basilar occlusion (ie, classic LVO patients and patients with proximal MCA-M2 and basilar occlusions). A further sub-group included in the analyses were those patients with MCA-M2 and basilar occlusions.

Imaging protocol

The routine imaging protocol at our hospital includes brain NCCT, CTA and CTP. CTP imaging is performed by a 320-slice Toshiba One scanner (Canon Medical Systems, Otawara, Japan), and post-processed using MIStar (Apollo Medical Imaging Technology, Melbourne, Australia) to generate perfusion maps including automated core-penumbra maps. Penumbra is defined as tissue with a delay time of three seconds or longer and a relative cerebral blood flow of 30% or more compared to the contralateral hemisphere, and ischemic core as tissue with a delay time of three seconds or longer and a relative cerebral blood flow of less than 30% of the contralateral hemisphere.(13)

Statistical analysis

All statistical analyses were performed using Stata version 15 (StataCorp LLC, TX, USA). Means are followed by standard deviation and medians are followed by interquartile range. Statistical estimates are reported with 95% confidence intervals. Sensitivity, specificity and AUC were calculated based on vessel occlusion detection by Hunter-8 and ACT-FAST. Sensitivity, specificity and AUC of Hunter-8 and ACT-FAST were calculated for classic LVO, extended LVO and the subgroup of patients with proximal MCA-M2 segment occlusion and basilar occlusions. The AUC of Hunter-8 and ACT-FAST were statistically compared using a chi-squared analysis.

Ethics

The study was approved by the Hunter New England Local Health District Human Research Ethics Committee (Reference No:11/08/17/4.01).

RESULTS

The analysis included 147 suspected stroke patients from June 2018 to January 2019; of these, 21 patients were excluded (17 had a brain haemorrhage on the brain NCCT and 4 patients had incomplete clinical data), leaving a total of 126 in the final analysis. The median age of the patients was 69 [60–81] years, and the median NIHSS was 6 [3–14] (Table 1). Of the patients, 83 had an ischemic stroke; of these, 57 had a vessel occlusion. There were 24 patients with a classic LVO (11 MCA-M1, 5 terminal-internal carotid artery, 8 tandem) and 34 with an extended LVO (classic LVO plus 8 with proximal MCA-M2 and 2 basilar artery occlusions). Of the 83 ischemic stroke patients, 34 received reperfusion treatment (8 thrombolysis, 24 EVT, 2 both). None of the TIA or mimic patients received reperfusion treatment.

Table 1. Baseline characteristics of the population (n=126)

Characteristic	Value
Number total (% female)	126 (41.3)
Age median [IQR]	69 [60–81]
NIHSS score median [IQR]	6 [3–14]
Diagnosis – no (%)	
Ischemic stroke	83 (65.9)
TIA	15 (11.8)
Mimic	28 (22.2)
Occlusion location – no (%)	
No occlusion	69 (54.8)
M1	11 (8.7)
M2 proximal	8 (6.3)
M2 distal	5 (4.0)
M3/distal MCA	6 (4.8)
PCA	2 (1.6)
ACA	3 (2.4)
T-ICA	5 (4)
ICA – extra cranial	7 (5.6)
Basilar	2 (1.6)
Tandem	8 (6.3)
Ischemic stroke lesion volume (mL) – median [IQR]	
Total lesion volume	59 [21–119.5]
Core volume	8.5 [2–23.5]
Penumbra volume	43 [13–91]
Reperfusion therapy – no (% stroke patients)	
No	49 (59)
Thrombolysis only	8 (9.6)
Thrombectomy only	24 (28.9)
Both	2 (2.4)

IQR: inter quartile range; NIHSS: National Institutes of Health Stroke Scale; TIA: transient ischemic attack; MCA: middle cerebral artery; M1: first segment of MCA; M2: second segment of MCA; M3: third segment of MCA; PCA: posterior cerebral artery; ACA: anterior cerebral artery; TICA: terminal internal carotid artery; ICA: internal carotid artery

The Hunter-8 and ACT-FAST scores for classic LVO and extended LVO patients are reported in Table 2. Of 24 patients with classic LVO, 18 (75%) had a Hunter-8 score ≧ 8, and 6 (25%) had a Hunter-8 score < 8; 15 (63%) were ACT-FAST positive, and 9 (38%) were ACT-FAST negative.

Table 2. Hunter-8 and ACT-FAST scores for LVO and non-LVO patients

	Hunter-8		ACT-FAST	
	< 8	≧ 8	Negative	Positive
Classic LVO - n(%)				
Yes	6 (25)	18 (75)	9 (38)	15 (63)
No	85 (83)	17 (17)	94 (92)	8 (8)
Extended LVO - n(%)				
Yes	14 (41)	20 (59)	18 (53)	16 (47)
No	77 (84)	15 (16)	85 (92)	7 (8)

LVO: large vessel occlusion

Of 34 patients with extended LVO, 20 (59%) had a Hunter-8 score ≧ 8, and 14 (41%) had a Hunter-8 score < 8; 16 (47%) were ACT-FAST positive, and 18 (53%) were ACT-FAST negative.

The sensitivity, specificity and AUC of the two scales (Hunter-8 and ACT-FAST) are reported in Table 3. Hunter-8 had an AUC of 0.79 (0.70–0.89) for detection of classic LVO, and an AUC of 0.71 (0.62–0.80) for extended LVO. ACT-FAST had an AUC of 0.77 (0.67–0.88) for classic LVO, and an AUC of 0.70 (0.61–0.79) for extended LVO. The scales detected proximal M2 and basilar occlusions with an AUC of 0.42 (0.32–0.52) and 0.43 (0.36–0.51) respectively. There was no statistically significant difference between the AUC of Hunter-8 and ACT-FAST for classic LVO or extended LVO (p-value of 0.75 and 0.75 respectively). The positive predictive value, negative predictive value and overall accuracy estimates are shown in the Supplementary Materials (Table S1).

Table 3. Sensitivity, specificity and AUC of Hunter-8 and ACT-FAST

LVO definition	Sens.(%)	Spec.(%)	AUC (95% CI)
Classic LVO			
Hunter-8	75	83	0.79 (0.70–0.89)
ACT-FAST	63	92	0.77 (0.67–0.88)
Extended LVO			
Hunter-8	59	84	0.71 (0.62–0.80)
ACT-FAST	47	92	0.70 (0.61–0.79)
Proximal M2 and basilar LVO			
Hunter-8	13	70	0.42 (0.32–0.52)
ACT-FAST	7	80	0.43 (0.36–0.51)

LVO: large vessel occlusion; Sens.: sensitivity; Spec.: specificity; AUC: area under the curve; CI: confidence interval; M2; second segment of middle cerebral artery

DISCUSSION

We have shown that the Hunter-8 and ACT-FAST scales detect classic LVO with similar AUC (0.79 and 0.77), with Hunter-8 being slightly more sensitive (75% vs. 63%), while ACT-FAST is more specific (92% vs. 83%). A recent prospective study comparing eight international pre-hospital stroke scales (not including the Australian scales reported here) found comparable AUC in the range of 0.72–0.83.(14) Our findings therefore suggest that both scales perform similarly to others used internationally.

We conducted a sub-analysis on patients with occlusion locations (proximal M2, basilar) that were not included in the pivotal RCTs but are nevertheless increasingly treated with EVT in clinical practice. We showed that both Hunter-8 and ACT-FAST perform poorly (AUC of 0.42 and 0.43 respectively). It is therefore likely that the fair performance of the scales for detection of extended LVO (AUC of 0.71 and 0.70 respectively) reflects their ability to detect classic LVO. Clinical identification of patients with basilar artery occlusion is notoriously challenging, even in a hospital setting.(15) Similarly, M2 branch occlusions present a diagnostic challenge, given the variability of vascular territory and brain representation areas which may be affected.(16) In both instances, there is not as yet randomised trial evidence to indicate superior outcome with EVT.(17) However, the available evidence suggests likely a smaller treatment effect than for the more common proximal MCA and distal ICA occlusions.(17,18)

Compared to the initial pilot study, the overall accuracy of Hunter-8 was similar (0.79 vs. 0.82).(10) However, the AUC of ACT-FAST has previously been reported as 0.94 compared to 0.77 in our study.(11) This may be due to differences in patient mix, training and implementation between the region where the score was validated and ours.

This study is limited by the small sample size, particularly for extended LVO stroke, as data were collected over a short period of time (six months), which can affect our results including those related to more distal occlusions. Therefore, larger datasets exploring this are needed. Furthermore, our study was set in the emergency department with a stroke fellow assessing suspected stroke patients using these scales, and therefore requires replication in the pre-hospital setting where both the environment in which the assessment is carried out as well as the level of expertise of the assessor might affect the ability of the Hunter-8 and ACT-FAST scales to detect LVO. However, our findings suggests that these scales might not be a robust tool to identify those patients with basilar and distal MCA occlusions. For such a tool to be clinically useful, sensitivity would need to increase many-fold, which seems unlikely to be achievable for a pre-hospital tool.

CONCLUSION

In conclusion, both Hunter-8 and ACT-FAST represent a significant opportunity to identify patients with proven benefit from thrombectomy (classic LVO) in the pre-hospital setting to enable optimal transportation decisions to minimise time to treatment and maximise patient benefits. However, M2 and basilar occlusions may be more challenging to identify with these scales.

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COMPETING INTERESTS

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SUPPLEMENTARY MATERIALS

Table S1. Positive predictive value, negative predictive value and overall accuracy estimate of Hunter-8 and ACT-FAST for different LVO definitions

LVO definition	Positive predictive value	Negative predictive value	Overall accuracy estimate
Classic LVO			
Hunter-8	51%	93%	82%
ACT-FAST	65%	91%	87%
Extended LVO			
Hunter-8	57%	85%	77%
ACT-FAST	70%	83%	80%
Proximal M2 and basilar LVO			
Hunter-8	6%	86%	63%
ACT-FAST	4%	86%	71%

LVO: large vessel occlusion