Validation of the National Institutes of Health Stroke Scale-8 to Detect Large Vessel Occlusion in Ischemic Stroke

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Background: Patients with acute ischemic stroke and large vessel occlusion (LVO) may benefit from prehospital identification and transfer to a center offering endovascular therapy. *Aims:* We aimed to assess the accuracy of an existing 8-item stroke scale (National Institutes of Health Stroke Scale-8 [NIHSS-8]) for identification of patients with acute stroke with LVO. *Methods:* We retrospectively calculated NIHSS-8 scores in a population of consecutive patients with presumed acute stroke assessed by emergency medical services (EMS). LVO was identified on admission computed tomography angiography. Accuracy to identify LVO was calculated using receiver operating characteristics analysis. We used weighted Cohen's kappa statistics to assess inter-rater reliability for the NIHSS-8 score between the EMS and the hospital stroke team on a prospectively evaluated subgroup. *Results:* Of the 551 included patients, 381 had a confirmed ischemic stroke and 136 patients had an LVO. NIHSS scores were significantly higher in patients with LVO (median 18; interquartile range 14-22). The NIHSS-8 score reliably predicted the presence of LVO (area under the receiver operating characteristic curve .82). The optimum NIHSS-8 cutoff of 8 or more had a sensitivity of .81, specificity of .75, and Youden index of .56 for prediction of LVO. The EMS and the stroke team reached substantial agreement ($\kappa = .69$). *Conclusions:* Accuracy of the NIHSS-8 to identify LVO in a population of patients with suspected acute stroke is comparable to existing prehospital stroke scales. The scale can be performed by EMS with reasonable reliability. Further validation in the field is needed to assess accuracy of the scale to identify patients with LVO eligible for endovascular treatment in a prehospital setting. **Key Words:** Acute stroke therapy—ischemic stroke—endovascular therapy—thrombectomy—large vessel occlusion—emergency medical services.

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Introduction

When compared with intravenous thrombolysis (tissue plasminogen activator, alteplase), endovascular treatment (EVT) for acute ischemic stroke has been shown to be more effective in improving the outcome of selected patients with ischemic stroke due to large vessel occlusion (LVO).[1-7]

To date, only a limited number of centers are capable of offering EVT for acute ischemic stroke and function as a comprehensive stroke center, of which most are situated in a metropolitan area. To address the inequity in access to EVT for patients with ischemic stroke located in rural, regional, and outer metropolitan areas, a "drip and ship" strategy can be used. In this model, patients with acute stroke are transported to the nearest hospital, where thrombolysis is administered to eligible patients. If computed tomography (CT) angiography shows an LVO, patients are then shipped to the nearest center providing EVT. The time taken to provide local hospital thrombolysis and to transfer the stroke patient to a comprehensive stroke center might, however, result in significant delays that can jeopardize potential reperfusion benefit.[8-10] If sufficiently accurate and reliable identification of LVO could occur before hospital arrival, direct triage of patients in outer metropolitan and regional areas to a comprehensive stroke center might help avoid time delays due to secondary hospital transfers.

Aims

We aimed to assess the accuracy of an existing, cut-down National Institutes of Health Stroke Scale-8 (NIHSS-8) for identification of patients with LVO, to validate the scale in a general cohort of patients suspected with acute ischemic stroke assessed by emergency medical services (EMS), and to test the inter-rater reliability of the NIHSS-8 between the EMS and the hospital stroke team.[11]

Methods

Patient Cohort

The study population consisted of consecutive patients with suspected acute stroke for whom the hospital acute stroke team was activated by EMS between 2012 and 2016 in a single center in Australia. Patients who were assessed by either EMS or the hospital stroke team only were excluded from the analysis. The center functions as the only comprehensive stroke center providing care for a population of 800,000 across an area of 29,145 km^2. At the time of data collection, the stroke team was activated only for patients with acute ischemic stroke within a 4.5-hour window from stroke symptom onset. The hospital stroke team was notified either by local ambulance paramedics prior to hospital arrival or by emergency physicians if a patient arrived at the emergency department without prior ambulance transport. Ethics approval for the use of the NIHSS-8 by EMS in our local health district was granted by the Hunter New England Health Human Research Ethics Committee (Ref number: 09/02/18/4.04).

Development of the NIHSS-8

The scale consists of 8 NIHSS items selected by stroke expert consensus to be more likely affected in large strokes underpinned by LVO (Fig 1).[11] The scale had been in use since 2010 and initially served the purpose of identifying patients eligible for thrombolytic therapy. Investigators (A.G., N.S., M.P., and C.L.) trained regional EMS in the use of the scale using the publically available online NIHSS training resources during a 1-week training session. Training was thereafter continued outside of the regional EMS control centers. Items regarded to be difficult to perform reliably by EMS after the initial training phase (e.g., assessment of visual field deficits, ataxia, or aphasia) were excluded from the final 8-item scale.

Data Collection

Admission NIHSS and imaging data were retrospectively analyzed. NIHSS data were collected upon patient admission to the emergency department by the hospital stroke team. All stroke team members maintain annual NIHSS certification and are highly experienced stroke clinicians. NIHSS-8 scores were calculated from the admission NIHSS score. To assess inter-rater reliability, the NIHSS-8 score was prospectively scored in a subgroup of 64 patients suspected with acute ischemic stroke. In that patient subgroup, EMS performed NIHSS-8 scoring upon patient arrival in the emergency department triage unit. A blinded stroke team member then scored the full 15-item NIHSS within 5 minutes of EMS evaluation.

All suspected stroke patients evaluated by the stroke team underwent noncontrast CT and CT angiography (CTA) as part of the standard acute stroke assessment. CTA was performed using a 40-mL bolus of intravenous contrast (Ultravist 370, Bayer HealthCare, Whippany, NJ, USA). Images were acquired from the aortic arch to the top of the lateral ventricles. The presence or absence of LVO was assessed on admission CTA and defined as a target occlusion for EVT in the anterior circulation: either an occlusion of the M1 segment of the medial cerebral artery) or an internal carotid artery–M1 tandem occlusion. Other LVO (isolated common or internal carotid artery, more distal medial cerebral artery occlusions, anterior cerebral artery occlusions, and posterior territory LVO) were regarded as non-LVO patients as these are not routinely treated with EVT and evidence for EVT treatment in these subgroups is currently lacking. The presence or absence of a causal LVO in the cohort was reviewed by 2 experienced vascular neurologists and correlated with clinical data. Disagreement was resolved by consensus. Patients with incidental findings of cerebral artery occlusions deemed as noncausal for the current stroke were regarded as