External Validation of the Cincinnati Prehospital Stroke Severity Scale

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Background: The Cincinnati Prehospital Stroke Severity Scale (CPSSS) was recently developed to predict large-vessel occlusions (LVOs) in patients with acute ischemic stroke (AIS). In its derivation study, which consisted of patients enrolled in thrombolysis and endovascular therapy trials, the CPSSS had excellent discriminatory performance. We sought to externally validate the CPSSS in an independent cohort. *Methods:* Using our institution's prospective stroke registry, we calculated CPSSS scores for all patients diagnosed with AIS at Weill Cornell Medical Center in 2013 and 2014. The primary outcome was presence of LVO and the secondary outcome was a National Institutes of Health Stroke Scale (NIHSS) score of 15 or higher. Harrell's *c*-statistic was calculated to determine the CPSSS score's discriminatory performance. Using the previously defined cut-point of 2 or higher (range 0-4), we evaluated the test properties of the CPSSS for predicting study outcomes. *Results:* Among 751 patients with AIS, 664 had vessel imaging and were included in the final analysis. Of these patients, 80 (14.2%) had LVOs and 117 (17.6%) had an NIHSS score of 15 or higher. The median CPSSS score was 0 (interquartile range 0-1) and 133 patients (20%) had scores of 2 or higher. *c*-statistic was .85 (95% confidence interval [CI] .81-.90) for predicting LVO and .94 (95% CI .92-.97) for predicting an NIHSS score of 15 or higher. Using a cut-point of 2 or higher, the CPSSS was 70.0% sensitive and 86.8% specific for predicting LVO, and 87.2% sensitive and 94.3% specific for predicting an NIHSS score of 15 or higher. *Conclusions:* In a cohort of patients with AIS treated at a tertiary-care stroke center, the CPSSS had reasonable sensitivity and specificity for predicting LVO and severe stroke. Future studies should aim to prospectively validate the score in emergency responders. **Key Words:** Stroke—ischemic stroke—large-vessel occlusion—clinical prediction score—cerebral infarction—acute stroke therapy.

Introduction

Following the recently successful trials of endovascular therapy for acute ischemic stroke (AIS) from large-vessel occlusions (LVOs),[1-5] multiple clinical scoring systems have been developed to aid clinicians in identifying potential candidates for endovascular therapy. Examples include the 3-Item Stroke Scale,[6] the Rapid Arterial Occlusion Evaluation Scale,[7] and the Cincinnati Prehospital Stroke Severity Scale (CPSSS).[8] Such scales could potentially enable emergency medical services to circumvent primary stroke centers in favor of comprehensive stroke centers with endovascular capability, thereby increasing endovascular therapy rates and reducing treatment times.

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The newly created CPSSS is based on individual National Institutes of Health Stroke Scale (NIHSS) items and was derived using a dataset containing 624 patients from 2 National Institute of Neurological Disorders and Stroke Tissue Plasminogen Activator Stroke Study trials. In this population, the CPSSS was shown to have a sensitivity of 89% and a specificity of 78% for identifying patients with an NIHSS score of 15 or higher.[9] Using a 303-patient dataset drawn from the Interventional Management of Stroke Trial, the CPSSS was shown to have a sensitivity of 83% and specificity of 40% for identifying patients with LVO.[10] Despite adequate sensitivity, the scale was derived and validated in a patient population culled from prospective thrombolysis and endovascular therapy trials, raising the possibility of nongeneralizability and selection bias toward patients with good baseline neurological status and higher stroke severity. Considering these limitations in the development of the CPSSS, we sought to externally validate the CPSSS in an independent cohort of AIS patients.

Methods

Study Design and Population

This was a retrospective cohort study using a prospectively collected registry of patients diagnosed with AIS at New York-Presbyterian Hospital/Weill Cornell Medical College, a tertiary-care teaching hospital and a certified primary stroke center with 24-7 endovascular capability. Our cohort comprised all patients diagnosed with AIS in 2013 and 2014 at our center in either the inpatient or emergency settings. The institutional review board of Weill Cornell Medical College approved the creation and maintenance of this registry, as well as the analysis for the present study. Formal consent was not required for this retrospective study.

Measurements

From the electronic medical record, a single stroke research fellow (G.G.) abstracted each patient's recorded NIHSS score at the time of initial neurological consultation. Both the components of the NIHSS and the total NIHSS had been previously entered into the electronic medical record at the time of initial consultation. Using components of the NIHSS, the CPSSS score, which was our predictor of interest, was determined for each patient. The CPSSS is a simple scoring system ranging from 0 to 4, with 2 points assigned for conjugate gaze deviation (≥1 on the NIHSS item for gaze), 1 point for abnormal level of consciousness questions and commands (≥1 on NIHSS items for consciousness questions and commands), and 1 point for severe arm weakness (≥2 on NIHSS item for arm weakness). Individual CPSSS components, as well as the total CPSSS, were recorded.

Our primary outcome of interest was presence of LVO, which was determined by abstracting the attending neuroradiologist's final interpretation of available neuroimaging studies from the electronic medical record. In keeping with the definition of LVO used in the CPSSS derivation study, patients were considered to have LVO only if one of the following occlusions were demonstrated: extracranial or intracranial internal carotid artery, M1 segment of the middle cerebral artery, tandem occlusion involving both the extracranial internal carotid artery and the M2 segment of the middle cerebral artery, or basilar artery. LVO was considered present if any of these occlusions were demonstrated on at least 1 vessel imaging study (magnetic resonance angiography, computed tomographic angiography, or digital subtraction angiography). We recorded whether intravenous thrombolysis or endovascular therapy was performed. Our secondary outcome was an NIHSS score of 15 or higher (i.e., severe stroke).

Statistical Analysis

Descriptive statistics were used to determine the clinical characteristics of the study subjects, stratified by presence of LVO. Logistic regression was used to evaluate the association between individual components of the CPSSS and the outcomes of interest (e.g., presence of LVO and NIHSS score of 15 or higher). Harrell's *c*-statistic was used to evaluate the score's discriminatory performance. Using several different cut-points, including the previously defined cut-point of 2 or higher, we calculated the score's sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio for predicting our outcomes of interest.

Based on the results of our multivariate logistic regression analysis of the individual components of the CPSSS, which demonstrated that only conjugate gaze deviation and severe arm weakness were independently associated with LVO, we performed a post hoc sensitivity analysis examining the discriminatory performance of a modified score that incorporated only those 2 components. In this modified scale, 2 points were assigned for conjugate gaze deviation and 1 point was assigned for severe arm weakness with a possible score range of 0-3. Statistical analysis was performed with Stata (version 12.1; StataCorp., College Station, TX).

Results

Patient Characteristics

Among 751 patients with AIS, 664 (88%) had vessel imaging and were included in the final analysis. Of these patients, 80 (14.2%) had LVO and 117 (17.6%) had an NIHSS score of 15 or higher. Patients with LVO were similar in age, gender, race, and vascular risk factors to patients without LVO, although patients with LVO had