The Ischemic Stroke Predictive Risk Score Predicts Early Neurological Deterioration

Young Dae Kim, MD, PhD,*†[1] Hye-Yeon Choi, MD, PhD,‡[1] Yo Han Jung, MD,§ Joonsang Yoo, MD,* Hyo Suk Nam, MD, PhD,* Dongbeom Song, MD,* Ji Hoe Heo, MD, PhD,* and Gustavo Saposnik, MD, MSc, FAHA†

Background: Although early neurological deterioration (END) during the acute stroke period is known to be directly associated with poor short- and long-term outcomes, few studies have investigated the ability to predict END. The aim of this study was to investigate whether there are differences in the occurrence of END according to the ischemic stroke predictive risk score (iScore), which was developed to predict short- and long-term mortality. *Methods:* We collected data from 2150 consecutive ischemic stroke patients who were admitted to 3 study hospitals between January 2012 and June 2014. END was defined as an increase (≥4) in the National Institutes of Health Stroke Scale score within the first 72 hours of stroke onset. We calculated the 30-day iScore for each patient to determine the relationship between the iScore and occurrence of END. *Results:* Among 2150 patients, END was observed in 146 patients (6.8%). There was a positive correlation between the iScore and occurrence of END. After adjusting for potential confounders, the iScore was independently associated with END (odds ratio: 1.217 per 20-point increase in iScore, 95% confidence interval: 1.121-1.321, $P < .001$). There was good correlation between observed and expected outcomes predicted by the iScore (Pearson correlation coefficient: $r = .950$, $P < .001$). *Conclusions:* The iScore can predict the risk of END development within the acute stroke stage. **Key Words:** Ischemic stroke—outcome—prediction—risk score.

From the *Department of Neurology, Yonsei University College of Medicine, Seoul, Republic of Korea; †Stroke Outcomes Research Unit, Division of Neurology, Department of Medicine, St. Michael's Hospital, University of Toronto, Toronto, Ontario, Canada; ‡Department of Neurology, Kyung Hee University School of Medicine, Kyung Hee University Hospital at Kangdong, Seoul, Republic of Korea; and §Department of Neurology, Changwon Fatima Hospital, Changwon, Republic of Korea.

Received November 4, 2015; accepted December 9, 2015.

Contributions to the manuscript: Y.D.K. and H.Y.C. contributed to the study concept, design, and data acquisition as well as primary writing of the manuscript. G.S. contributed to the concept, design, interpretation, and supervision of the study as well as critical revision of the manuscript for important intellectual content. Y.H.J., J.Y., H.S.N., D.S., and J.H.H. contributed to data acquisition, interpretation of results, and revision of the manuscript.

Address correspondence to Gustavo Saposnik, MD, MSc, FRCPC, Division of Neurology, Department of Medicine, Stroke Outcomes Research Centre, St. Michael's Hospital, University of Toronto, 55 Queen Street E, Toronto, Ontario, M5C 1R6, Canada. E-mail: saposnikg@smh.ca.

[1] These authors contributed equally to this work.

1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2015.12.003

Introduction

Ischemic stroke is one of the leading causes of mortality and morbidity worldwide. Approximately 25%-30% of patients with ischemic stroke experience neurological complications, including early neurological deterioration (END).[1-4] END leads to poor neurological outcomes and also contributes to distress experienced by patients and their families in the acute stroke stage. The ability to predict risk factors for END can facilitate acute stroke management by improving clinical care and decision making and by enhancing communication between clinicians and patients.[5]

Different risk scores have been developed to predict outcomes after an ischemic stroke. However, most scores have not been tested for their ability to predict END. The ischemic stroke predictive risk score (iScore) is a developed and validated scoring system for the prediction of short- and long-term mortality after stroke.[6] Studies conducted in different countries have consistently reported the high predictability and reliability of this scoring system in stroke patients.[5,7-11] Given that most of the variables used to compute the iScore are known to be associated with END,[12,13] we hypothesized that the iScore can predict the occurrence of END within the acute stroke stage. The aim of the present study, therefore, was to investigate whether the iScore is an independent predictor of END.

Methods

Study Population

This retrospective observational study was designed to determine the predictive value of the iScore for END. For this, we collected data on all consecutive acute ischemic stroke patients who were admitted to 3 large hospitals (Severance Stroke Center, Kyung Hee University Kangdong Hospital Stroke Center, and Changwon Fatima Hospital) in Seoul and Changwon, Korea, between January 2012 and June 2014. All patients underwent brain imaging via brain computed tomography and/or magnetic resonance imaging. Patients were evaluated via standardized patient evaluations and care pathways for stroke, including previous medical history, vascular risk factors, clinical manifestations, standard blood tests, cerebral angiography (magnetic resonance angiography, computed tomography angiography, and/or catheter angiography), and cardiac evaluation.

During the study period, a total of 3351 patients with acute ischemic stroke within 7 days were admitted to one of the participating institutions. We excluded patients with a transient ischemic attack (n = 169), those with a missing initial National Institutes of Health Stroke Scale (NIHSS) score (n = 18), and those with missing laboratory data (n = 113). After excluding 901 patients who were admitted after 24 hours of stroke onset, 2150 patients were enrolled in this study.

The present study was approved by the institutional review board at each participating hospital. The requirement for informed consent was waived.

Exposure: Definition of END

Initial stroke severity was determined using the NIHSS, which was assessed by a stroke neurologist. During hospitalization, the neurological status of all stroke patients was evaluated daily using the NIHSS score. In this study, END was defined as having any new or progressive focal neurological symptoms with an increase in the NIHSS score of 4 or higher compared with the initial NIHSS score during the first 72 hours of hospitalization. If neurological worsening was observed, brain imaging was performed.

Among patients with END, the following causes of END were determined based on previously defined criteria[14]: recurrent stroke (i.e., new stroke syndrome different from index stroke as supported by appropriate neuroimaging), stroke progression (i.e., worsening of index stroke not related to recurrent stroke, symptomatic hemorrhagic transformation, or other medical cause), symptomatic hemorrhagic transformation, other medical cause (e.g., deep vein thrombosis, pulmonary embolism, myocardial infarction), or unknown cause.

Clinical Variables

Information about vascular risk factors such as hypertension, diabetes, hypercholesterolemia, and smoking was collected. Information about prior medical history, including previous ischemic stroke or ischemic heart disease, peripheral arterial occlusive disease, renal dialysis, underlying malignancy, and disability before the index stroke, was also collected. The underlying mechanism of index stroke was determined based on the Trial of Org 10172 in Acute Stroke Treatment classification.[15] For the iScore calculation, the stroke severity was categorized into 4 groups based on the NIHSS score with the following rule: Canadian Neurological Scale (CNS) score of 0 equals an NIHSS score of 23 or higher, a CNS score of 1-4 equals an NIHSS score of 14-22, a CNS score of 5-7 equals an NIHSS score of 9-13, and a CNS score of 8 or higher equals an NIHSS score of 8 or lower.[16] We calculated the 30-day iScore for each patient using a previously reported method.[6]

Statistical Analysis

Statistical analyses were performed using the Windows IBM SPSS software package (version 21.0, Chicago, IL, USA) and R software package version 3.0.1 (http://www.R-project.org). Categorical variables were compared using either a chi-square or Fisher's exact test, and continuous variables were compared using either Student's *t*-test or the Mann–Whitney test as appropriate. The relationship between the probability of having END and the iScore (1-point intervals) was expressed using