Analysis of the Usefulness of the WORSEN Score for Predicting the Deterioration of Acute Ischemic Stroke

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Background: Early neurological worsening is associated with increased mortality and long-term functional disability. We developed the WORSEN score for predicting whether patients with stroke will deteriorate during the week after stroke onset and investigated its usefulness. *Patients and Methods:* We retrospectively investigated the cases of 478 patients who were admitted to Juntendo University Hospital between April 2007 and March 2009. Neurological deterioration was defined as a worsening of 4 points or higher on the National Institute of Health Stroke Scale score within 1 week of admission. Based on a previous study, we developed the WORSEN score, which was derived from the following factors: wrong (poor) blood sugar control (W), old myocardial infarction (O), radiological findings (R), infarct size (S), elevated low-density lipoprotein cholesterol (E), and neurological findings (N). Next, we investigated the utility of this scoring system in 456 other patients who were admitted to Juntendo University Hospital and Juntendo Urayasu Hospital between October 2013 and December 2014. *Results:* First, we checked the utility of the WORSEN score for detecting worsening in cases of stroke. In the first patient group, deterioration was noted in 32.5% of the patients with scores higher than 3 points (sensitivity: .704 and specificity: .744). For checking reproductivity on using the second group, deterioration was detected in 36.1% of the patients with WORSEN scores higher than 3 points (sensitivity: .740 and specificity: .835). *Conclusions:* Careful attention should be paid to patients with acute stroke with high WORSEN scores. The WORSEN score might become a valuable tool for detecting the neurological deterioration of ischemic stroke. **Key Words:** Acute ischemic stroke—neurological deterioration—diabetes—dyslipidemia—history of myocardial infarction.

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Received March 26, 2017; revision received June 29, 2017; accepted July 8, 2017.

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1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2017.07.005

Introduction

We sometimes experience cases in which ischemic strokes deteriorate or recur in the early phase after onset. The clinical deterioration of ischemic strokes is usually associated with a significant worsening of the patient's neurological function and a reduction in their ability to perform activities of daily living.[1] Furthermore, early neurological deterioration after an acute ischemic stroke has been found to be related to mortality and worse functional outcomes.[2] It is, therefore, important to stabilize patients who suffer from acute ischemic strokes and to prevent any deterioration in their clinical status.

The worsening of acute strokes was reported to be correlated with various factors, including age, a previous diagnosis of diabetes mellitus (DM) or coronary heart disease, the detection of marked hypodensity on the initial computed tomography scan, the presence of a hyperdense media sign,[3] the presence of middle cerebral artery (MCA) flow velocity changes, a poor cerebral hemodynamic reserve,[4] increased stroke severity,[5] the presence of internal carotid artery (ICA) or MCA occlusion,[2] the degree of carotid stenosis,[5] the plasma glucose level, the plasma ferritin level,[6] the levels of excitotoxic amino acids in cerebrospinal fluid and blood,[7] the plasma levels of proinflammatory cytokines,[8] the concentration of nitric oxide in cerebrospinal fluid,[7] the plasma D-dimer level,[9] blood pressure (BP),[5] and body temperature.[2] However, there are no scoring systems for assessing stroke deterioration such as the $CHADS_2$ score[10] and the $ABCD^2$ score.[11]

The National Institutes of Health Stroke Scale (NIHSS) has recently been widely used to define early neurological deterioration, with a gain of more than 4 points during the first 48 or 72 hours being the most consistently used definition.[12-14] However, some patients' conditions deteriorate at 4-6 days after stroke onset. We have previously reported predictive factors for the occurrence of stroke deterioration within 1 week of the onset of an acute stroke,[15] and neurological deterioration was found to be closely related to dyslipidemia (DL) and diabetes control, a history of myocardial infarction, and an initial NIHSS score higher than 8. Moreover, radiological studies have shown that neurological deterioration was correlated with ICA occlusion, MCA M1-2 occlusion, striatocapsular infarctions, pontine lesions, and lesion sizes of 15-30 mm. In the present study, based on the findings of our previous study, we developed the WORSEN score as a tool for predicting stroke deterioration within 1 week of stroke onset and investigated its usefulness.

Patients and Methods

Patients

The first study population (group 1) encompassed 537 Japanese patients who were admitted to our department (Neurology) at Juntendo University Hospital within 2 days of suffering an acute ischemic stroke between April 2007 and March 2010. Brain computed tomography or magnetic resonance imaging (MRI) and electrocardiography were performed in all patients. Brain MRI was conducted in all patients who consented to participate in the study. We excluded 58 patients due to a diagnosis of transient ischemic attack (TIA), treatment with an intravenous tissue plasminogen activator or endovascular treatment, or a lack of data.

We retrieved the following information from the medical records of each patient to calculate the baseline WORSEN score and to analyze its association with subsequent deterioration: (1) demographic data; (2) risk factors for stroke: hypertension (HT, systolic BP of >140 mm Hg or diastolic BP of >90 mm Hg or drug treatment for HT), DM (a glycated hemoglobin [HbA1c] level of >6.8% on National Glycohemoglobin Standardization Program [NGSP] definition, or drug treatment for DM), DL (a low-density lipoprotein [LDL] cholesterol level of >140 mg/dL, a high-density lipoprotein cholesterol level of <40 mg/dL, a triglyceride level of >149 mg/dL, or drug treatment for DL), the cardioembolic source according to the Trial of Org 10172 in Acute Treatment (TOAST) classification,[16] TIA, and smoking history (as reported by the patient and their family); (3) vital signs at presentation (BP); (4) blood glucose profile, lipid profile, and laboratory findings on admission; (5) medications being taken upon admission, with particular attention paid to antiplatelets, anticoagulants, antihypertensives, and statins (we did not collect information about the duration of medication use, daily use, or compliance); (6) stroke mechanism according to the TOAST criteria[16]; and (7) the baseline NIHSS score,[17] as recorded by stroke-trained neurologists who were certified in the application of the NIHSS on admission, at 7 days after admission, and upon discharge. The deterioration of neurological findings was defined as a worsening of the NIHSS score by 4 points or higher within 1 week of admission to the hospital.

The second study population (group 2) encompassed 488 Japanese patients with ischemic stroke who were admitted to our department (Neurology) at Juntendo University Hospital or Juntendo Urayasu Hospital within 2 days of suffering an acute ischemic stroke between October 2013 and December 2014. This dataset was used to analyze the usefulness of the WORSEN score for predicting deterioration. We excluded 32 patients due to a diagnosis of TIA, treatment with an intravenous tissue plasminogen activator or endovascular treatment, or a lack of data.

WORSEN Score

In the logistic regression analysis conducted in our previous study,[15] the following factors were identified as parameters that might be related to neurological deterioration: a history of myocardial infarction (odds ratio [OR]: