

# Assessment of cerebral infarction after transient cerebral ischemic attack by ABCD<sup>2</sup> score combined with the position of intracranial vascular stenosis

Hong-Yan Xi, MD\*, Zhi-Hua Si, BS, Jia-Cheng Li, BS, Jian-Guo Zhu, MD, Hai-Yan Yan, MD

## Abstract

This study aims to investigate the value of the ABCD<sup>2</sup> score combined with the position of the offending vessel stenosis in predicting the risk of transient ischemic attack (TIA) to develop into cerebral infarction.

The ABCD<sup>2</sup> score and head magnetic resonance imaging + magnetic resonance angiography (MRA) results of 192 patients with TIA were retrospectively analyzed. With the 7th day as the endpoint time, these patients were divided into 3 groups, according to ABCD<sup>2</sup> scores: low-risk group (n=105), moderate-risk group (n=60), and high-risk group (n=27). Blood vessels were screened using head MRA results, and patients were accordingly divided into 2 groups: proximal vascular stenosis group (n=71) and nonproximal vascular stenosis group (n=171). Then, the association of the position of the intracranial vascular stenosis and ABCD<sup>2</sup> score with short-term prognosis was analyzed.

Based on the ABCD<sup>2</sup> score, the incidence of cerebral infarction after 1 week was significantly higher in the high-risk group (85.7%) than in the moderate-risk group (16.7%) and low-risk group (1.9%), and the differences were statistically significant ( $P < .05$ ). When the ABCD<sup>2</sup> score was  $\geq 4$  points, the incidence of cerebral infarction after 1 week was significantly higher in the proximal vascular stenosis group (59.1%) than in the nonproximal vascular stenosis group (30.8%), and the difference was statistically significant ( $P < .05$ ). When the ABCD<sup>2</sup> score was  $< 4$  points, the incidence of cerebral infarction after 1 week in the proximal stenosis group (2%) was not significantly different from that in the nonproximal stenosis group (1.9%,  $P > .05$ ).

The ABCD<sup>2</sup> score combined with proximal offending vessel stenosis can improve the short-term prediction of cerebral infarction in patients with TIA.

**Abbreviations:** CT = computed tomography, MRA = magnetic resonance angiography, MRI = magnetic resonance imaging, TIA = transient ischemic attack.

**Keywords:** ABCD<sup>2</sup> score, cerebral infarction, head magnetic resonance angiography imaging, prediction, proximal vascular stenosis, transient cerebral ischemic attack

## 1. Introduction

Transient ischemic attack (TIA) is a recoverable and transient neurological deficit attack caused by focal cerebral ischemia in the brain, spinal cord, and retina, and is a common clinical ischemic cerebrovascular disease.<sup>[1]</sup> Furthermore, it is the most

important risk factor for acute ischemic cerebrovascular disease, a super early warning signal for cerebral infarction.<sup>[2]</sup> Clinically, secondary cerebral infarction occurs in one-third of TIA patients, two-third of these occur within 1 week, and the incidence of cerebral infarction in 30 days is 8.2% to 16.3% in TIA patients.<sup>[3,4]</sup> Therefore, the rapid and accurate risk stratification of TIA patients is critical. Furthermore, assessment based on the combination of clinical features and imaging data is of great significance. The ABCD<sup>2</sup> score is the most common risk assessment tool for stroke after TIA in clinic, which has good predictive value for the occurrence of cerebral infarction within 1 week after TIA.<sup>[5,6]</sup> However, this scoring system does not include imaging. Therefore, the efficacy of clinical application is not high. Previous studies have revealed that the ABCD<sup>2</sup> score combined with carotid artery stenosis and other indicators can better predict the risk of early stroke in TIA patients.<sup>[7]</sup> Endothelial dysfunction is the key to the pathogenesis of atherosclerosis. Atherosclerosis can cause vascular stenosis, and the occurrence of TIA is closely related to atherosclerosis. The study conducted by Ottaviani et al<sup>[8]</sup> also confirmed that angiostegnosis is an independent risk factor for ischemic stroke. The present study aims to investigate the value of the ABCD<sup>2</sup> score combined with proximal stenosis of the offending vessel in predicting cerebral infarction within 1 week after TIA.

Editor: Bernhard Schaller.

This study was supported by Science and Technology Bureau of Hengshui City, Hebei province (2014) No. thirty-ninth 14014A.

The authors have no conflicts of interest to disclose.

Department of Neurology, Harrison International Peace Hospital, Hengshui, China.

\* Correspondence: Hong-Yan Xi, Department of Neurology, Harrison International Peace Hospital, NO. 180 East People's Road, Taocheng District, Hengshui 053000, China (e-mail: hongyanxi\_dr@163.com).

Copyright © 2019 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

Medicine (2019) 98:15(e15081)

Received: 30 July 2018 / Received in final form: 19 November 2018 / Accepted: 10 March 2019

<http://dx.doi.org/10.1097/MD.0000000000015081>

## 2. Data and methods

### 2.1. Subjects of study

A total of 192 TIA patients diagnosed in the Department of Neurology of Hengshui Halison International Peace Hospital in Hengshui City, Hebei province, from June 2015 to January 2017 were enrolled into this study. Among these patients, 108 patients were male and 84 patients were females, and the age of these patients ranged within 30 to 82 years old, with an average age of  $57.2 \pm 13.6$  years old. The diagnoses of all patients were in accordance with the criteria developed by the Fourth National Conference of Cerebrovascular Disease in 1996, and stenosis of the offending vessel in all patients was screened by head magnetic resonance angiography (MRA) examination. All patients underwent head computed tomography (CT) at admission in the hospital, and no corresponding focal lesions were detected by CT in any of the patients. All patients underwent head magnetic resonance imaging (MRI) MRA examination within 24 hours. The neurology specialist judged whether the cerebral infarction occurred based on the clinical manifestations of the patient, and the MRI diffusion-weighted examination of the head showed a new acute infarction. This study was conducted in accordance with the declaration of Helsinki and approved by the Ethics Committee of Hengshui Halison International Peace Hospital. Written informed consent was obtained from all participants.

### 2.2. Research methods

**2.2.1. The ABCD<sup>2</sup> scoring method.** All TIA patients were scored according to the ABCD<sup>2</sup> scoring method, which mainly included 5 items: age, blood pressure, clinical characteristics, duration of symptoms, and the presence of diabetes (Table 1). Patients were scored based on the above indicators, which were detected during the attack of TIA with the longest duration. According to the score, these patients were divided into 3 groups<sup>[9]</sup>: low-risk group (0–3 points), moderate-risk group (4–5 points), and high-risk group (6–7 points).

**2.2.2. Clinical treatment.** All patients were routinely given dual antiplatelet aggregation therapy immediately after diagnosis of TIA. Treatment plan: Aspirin (Bayer HealthCare, Beijing, China, National Pharmaceutical Standard J20130078) 100 mg/d, combined with clopidogrel hydrochloride (Shenzhen Xinli Thai Pharmaceutical Co., Ltd., Shenzhen, China, national medicine quasi-word H20000542) 75 mg/d, and at the same time using statin drugs to stabilize the plaque treatment.

**2.2.3. Head MRI+MRA scan.** A 3.0 dual gradient superconducting MRI system (Sigma Twin-Speed, GE Medical Systems, Boston) was adopted, in which the spatial resolution of the brain MRI examination was high, and the diffusion weighted imaging (DWI) sequence could display the ischemic

brain tissue at the early stage of the disease. When the DWI image presented with focal hyperintense signals and these signals were located in the blood supplying area correlated to the clinical symptoms, it is considered as a DWI abnormality. Head MRA examination was performed in all patients, The degree of intracranial stenosis was determined by Three-dimensional time of flight-MRA imaging method using the Warfarin–Aspirin symptomatic intracranial disease test criteria,<sup>[10]</sup> and the arteries were calculated as follows. Stenosis rate: stenosis rate =  $(1 - AS/AN) \times 100\%$ . AS is the narrowest diameter of the stenosis, and AN is the normal vessel diameter of the same artery. And the evaluated blood vessels in the head and neck included the following: the anterior cerebral artery, middle cerebral artery, posterior cerebral artery, siphon of the internal carotid artery, and basilar artery. The proximal vessels included: A1 segment of the anterior cerebral artery, M1 segment of the middle cerebral artery, P1 segment of the posterior cerebral artery, V4 segment of the vertebral artery, end of the internal carotid artery, and basilar artery.

**2.2.4. Determination of cerebral infarction.** In the present study, among these 192 TIA patients, 35 patients progressed into cerebral infarction within 1 week. The diagnosis of cerebral infarction was based on head CT and MRI results and clinical features, which were in line with the diagnostic criteria developed by the Fourth Academic Conference of Cerebrovascular Disease. All TIA patients underwent head MRI examinations. The clinical signs of all patients with cerebral infarction were in accordance with the head MRI results, and the cerebral infarction lesions were all new lesions. The observation time point of the endpoint event for all patients was the 7th day.

### 2.3. Statistical analysis

Data were statistically analyzed using statistical software SPSS 18.0, Chicago. Measurement data were expressed as mean  $\pm$  standard deviation ( $\bar{x} \pm SD$ ). Intergroup comparison was conducted using *t* test. Count data were evaluated using chi-squared test. *P* < .05 was considered statistically significant.

## 3. Results

### 3.1. The association of ABCD<sup>2</sup> scores and the progression into cerebral infarction within 1 week in TIA patients

The ABCD<sup>2</sup> scoring was performed in 192 TIA patients. Among these patients, the incidence of cerebral infarction was 1.9% in the low-risk group, 16.7% in the moderate-risk group, and 85.2% in the high-risk group. The incidence was significantly higher in the high-risk groups than in the moderate-risk group and low-risk group, and the differences were statistically significant (*P* < .05, Table 2).

**Table 2**

**The association of ABCD<sup>2</sup> scores and the incidence of cerebral infarction within 1 week in transient ischemic attack patients.**

Group	TIA	7 day incidence of cerebral infarction (%)
Low-risk group	105	2 (1.9)
Moderate-risk group	60	10 (16.7)*
High-risk group	27	23 (85.2) <sup>†,‡</sup>

TIA = transient ischemic attack.

\* Compared with the low-risk group, *P* < .05.

<sup>†</sup> Compared with the low-risk group, *P* < .05.

<sup>‡</sup> Compared with the moderate-risk group, *P* < .05.

**Table 1**

**ABCD<sup>2</sup> score criterion.**

Risk factor	Criterion	Score
Age	≥60	1
Blood pressure	≥140/90 mm Hg	1
Clinical symptoms	Unilateral weakness	2
	Allolalia without limb weakness	1
Duration	≥60 min	2
	10–59 min	1
Diabetes		1

**Table 3**

**Association of ABCD<sup>2</sup> scores combined with the position of the stenosis and the incidence of cerebral infarction within 1 week in transient ischemic attack patients.**

Group	ABCD <sup>2</sup> score	TIA	7 day incidence of cerebral infarction (%)
	Proximal vascular stenosis group	<4	49
	≥4	22	13 (59.1)*,†
Nonproximal vascular stenosis group	<4	56	1 (1.9)
	≥4	65	20 (30.8)

TIA = transient ischemic attack.

\* Compared with the nonproximal vascular stenosis group,  $P < .05$ .

† Compared with the moderate-risk group and the high-risk group,  $P < .05$ .

### 3.2. Association of ABCD<sup>2</sup> scores combined with the position of the stenosis with the incidence of cerebral infarction within 1 week in TIA patients

When the ABCD<sup>2</sup> score was  $\geq 4$  points, the incidence of cerebral infarction within 1 week was significantly higher in the proximal vascular stenosis group (59.1%) than in the nonproximal vascular stenosis group (30.8%), and the difference was statistically significant ( $P < .05$ ). When the ABCD<sup>2</sup> score was  $< 4$  points, the incidence of cerebral infarction within 1 week in the proximal stenosis group (2%) was not significantly different from that in the nonproximal stenosis group (1.9%,  $P > .05$ ; Table 3).

## 4. Discussion

TIA is a common clinical ischemic cerebrovascular disease, and is an independent risk factor for cerebral infarction.<sup>[11]</sup> Studies have revealed that the incidence of cerebral infarction in 1 week in TIA patients was up to 8% to 10.5%.<sup>[12,13]</sup> In the present study, among these 192 patients, 35 patients (18.2%) progressed into cerebral infarction within 1 week. This was far higher than that reported in foreign studies. In terms of the reasons, first, it may be correlated to human race.<sup>[14]</sup> Second, the patients included in the present study were all hospitalized patients, and their conditions were relatively severe, since patients with mild diseases do not visit the hospital. Therefore, the incidence of cerebral infarction increased.

TIA is an important and dangerous early warning event of ischemic stroke. Therefore, emergency clinical assessment and treatment after TIA can reduce the risk of stroke after TIA. How to quickly identify high-risk patients is crucial. Studies have revealed that the ABCD<sup>2</sup> score has good predictive value.<sup>[15]</sup> The ABCD<sup>2</sup> score was proposed by Johnston et al<sup>[9]</sup> in the United States, which is mainly used for the risk assessment of stroke after TIA. This has been verified by many studies at home and abroad, in which positive results have been achieved. The score includes 5 aspects (age, blood pressure, clinical characteristics, duration of symptoms, and the presence of diabetes) with a total of 7 points. In the present study, 192 patients were included, and these patients were divided into 3 groups, according to ABCD<sup>2</sup> scores: low-risk group, moderate-risk group, and high-risk group. These results revealed that the ABCD<sup>2</sup> score was positively correlated with the incidence of cerebral infarction within 1 week after TIA. The difference in the incidence of cerebral infarction within 1 week after TIA between the moderate-risk group and low-risk group was statistically significant. The difference in the incidence of cerebral infarction within 1 week after TIA between the

high-risk group and moderate-risk group was statistically significant. These results reveal that the higher the ABCD<sup>2</sup> score of TIA patients, the higher the incidence of cerebral infarction in the short term. This further confirms that the ABCD<sup>2</sup> score has predictive significance for early stroke in TIA patients. A study conducted by Ssi-Yan-Kai et al<sup>[16]</sup> revealed that intracranial arteriostenosis, especially proximal vascular lesions, can increase the risk of cerebral infarction from TIA within 1 week. In the present study, when the ABCD<sup>2</sup> score was  $\geq 4$  points, the incidence of cerebral infarction within 1 week was significantly higher in the proximal vascular stenosis group (59.1%) than in the nonproximal vascular stenosis group (30.8%), and the difference was statistically significant. After TIA, patients with proximal stenosis of the offending vessel were prone to cerebral infarction. Therefore, intracranial vascular stenosis has a significant correlation with the occurrence and development of cerebral infarction. Furthermore, there was a strong correlation between the ABCD<sup>2</sup> score and MRA results. The combination of the ABCD<sup>2</sup> score and MRA results can further improve the accuracy of the prediction.

In summary, the ABCD<sup>2</sup> score improved the predictive value for the risk of cerebral infarction after TIA, and the combination of the ABCD<sup>2</sup> score and proximal stenosis of intracranial offending vessel is of great significance for predicting the incidence of cerebral infarction within 1 week in TIA patients, which can significantly improve the accuracy of prediction. This is worthy of clinical popularization and application. There are some limitations in this study. The relationship between internal carotid artery and cerebral infarction has not been analyzed in detail. The degree of stenosis of the proximal intracranial vessels and the progression of TIA to cerebral infarction has not been analyzed. This is also the focus of future research.

## Author contributions

**Conceptualization:** Hong-Yan Xi.

**Data curation:** Zhi-Hua Si.

**Formal analysis:** Zhi-Hua Si, Jia-Cheng Li.

**Methodology:** Jia-Cheng Li.

**Resources:** Jian-Guo Zhu, Hai-Yan Yan.

**Supervision:** Hong-Yan Xi.

**Writing – original draft:** hong-yan xi.

**Writing – review & editing:** Hong-Yan Xi.

## References

- [1] van Rooy MJ, Duim W, Ehlers R, et al. Platelet hyperactivity and fibrin clot structure in transient ischemic attack individuals in the presence of metabolic syndrome: a microscopy and thromboelastography study. *Cardiovasc Diabetol* 2015;14:86.
- [2] Kang DW, Han MK, Kim HJ, et al. Silent new ischemic lesions after index stroke and the risk of future clinical recurrent stroke. *Neurology* 2016;86:277–85.
- [3] Sehatzadeh S. Is Transient ischemic attack a medical emergency? An evidence-based analysis. *Ont Health Technol Assess Ser* 2015;15:1–45.
- [4] Brouwer-Goossens D, Genugten LV, Lingsma H, et al. Determinants of intention to change health-related behavior and actual change in patients with TIA or minor ischemic stroke. *Patient Educ Couns* 2016;99:644–50.
- [5] Galvin R, Geraghty C, Motterlini N, et al. Prognostic value of the ABCD<sup>2</sup> clinical prediction rule: a systematic review and meta-analysis. *Fam Pract* 2011;28:366–76.
- [6] Merwick A, Albers GW, Amarenco P, et al. Addition of brain and carotid imaging to the ABCD<sup>2</sup> score to identify patients at early risk of stroke after transient ischaemic attack: a multicentre observational study. *Lancet Neurol* 2010;9:1060–9.

- [7] Korogi Y, Takahashi M, Mabuchi N, et al. Intracranial vascular stenosis and occlusion: diagnostic accuracy of three-dimensional, Fourier transform, time-of-flight MR angiography. *Radiology* 1994;193:187–93.
- [8] Ottaviani M, Vanni S, Moroni F, et al. Urgent carotid duplex and head computed tomography versus ABCD<sup>2</sup> score for risk stratification of patients with transient ischemic attack. *Eur J Emerg Med* 2016;23:19–23.
- [9] Johnston SC, Rothwell PM, Nguyen-Huynh MN, et al. Validation and refinement of scores to predict very early stroke risk after transient ischaemic attack. *Lancet* 2007;369:283–92.
- [10] Chen L, Zhan Q, Ma C, et al. Reproducibility of middle cerebral artery stenosis measurements by DSA: comparison of the NASCET and WASID methods. *PLoS One* 2015;10:e0130991.
- [11] Amarenco P, Lavallée PC, Labreuche J, et al. One-year risk of stroke after transient ischemic attack or minor stroke. *N Engl J Med* 2016;374:1533–42.
- [12] Chandratheva A, Geraghty OC, Luengo-Fernandez R, Rothwell PM. Oxford Vascular Study. ABCD<sup>2</sup> score predicts severity rather than risk of early recurrent events after transient ischemic attack. *Stroke* 2010;41:851–6.
- [13] Li J, Wang Y, Lin J, et al. CHANCE Investigators. Soluble CD40L is a useful marker to predict future strokes in patients with minor stroke and transient ischemic attack. *Stroke* 2015;46:1990–2.
- [14] Mok VC, Fan YH, Lam WW, et al. Small subcortical infarct and intracranial large artery disease in Chinese. *J Neurol Sci* 2003;216:55–9.
- [15] De Marchis GM, Weck A, Audebert H, et al. Copeptin for the prediction of recurrent cerebrovascular events after transient ischemic attack: results from the CoRisk study. *Stroke* 2014;45:2918–23.
- [16] Ssi-Yan-Kai G, Nasr N, Faury A, et al. Intracranial artery stenosis or occlusion predicts ischemic recurrence after transient ischemic attack. *AJNR Am J Neuroradiol* 2013;34:185–90.