Validation of the ABCD² Score to Identify the Patients With High Risk of Late Stroke After a Transient Ischemic Attack or Minor Ischemic Stroke

Jie Yang, MD; Jian-Hui Fu, MD; Xiang-Yan Chen, PhD; Yang-Kun Chen, MD; Thomas W. Leung, MD; Vincent Mok, MD; Yannie Soo, MD; Ka-Sing Wong, MD

Background and Purpose—The ABCD² score is able to predict the short-term risk of stroke after a transient ischemic attack/minor stroke. We aimed to explore its predictive value for long-term recurrent stroke.

Methods—Consecutive patients with a transient ischemic attack/minor stroke, hospitalized during a 2-year period, were followed up to document any further stroke and death stratified by a 7-point ABCD² score.

Result—A total of 490 patients were followed for an average of 40.5 months (SD, 10.7 months). Further stroke were identified in 76 (15.5%) patients and 62 (12.7%) patients died during follow-up. Multivariate Cox regression analysis showed that an ABCD² score >4 was found to be an independent risk factor for further stroke (hazard ratio, 2.27; 95% CI, 1.36 to 3.80) and for death (hazard ratio, 1.68; 95% CI, 0.99 to 2.85).

Conclusions—In addition to predicting short-term stroke risk, ABCD² score is a useful tool to predict long-term stroke risk after a transient ischemic attack or minor ischemic stroke. (Stroke. 2010;41:00-00.)

Key Words: ABCD² score ■ minor stroke ■ prognosis ■ recurrent stroke ■ transient ischemic attack

The ABCD² score is able to predict individuals with high risk of early and very early stroke (2 days, 7 days, and 30 days) after transient ischemic attack (TIA) and minor stroke.¹ ² However, whether the ABCD² score is able to predict the long-term risk of further stroke or death remains uncertain. The aim of our present study was to validate the ABCD² score in identifying patients with high risk of late stroke after a TIA or minor ischemic stroke in a general hospital.

Subjects and Methods
Consecutive patients who were hospitalized in the Prince of Wales Hospital, Hong Kong, with a definite diagnosis of TIA or minor stroke (the first National Institutes of Health Stroke Scale score <3 on admission) between January 2004 and December 2005 were recruited. Diagnosis was based on the discharge coding of the caring physicians. Patients with TIA/minor stroke were all admitted as a general policy of the emergency department in that period. Patients with atrial fibrillation were excluded. All patients underwent CT scan to exclude intracerebral hemorrhage.

The 7-point ABCD² score¹ was calculated retrospectively from our hospital record and from our prospective stroke registry at the Prince of Wales Hospital. Patients were regularly followed every 4 to 6 months at the hospital clinic or the community clinic and were prospectively interviewed at the outpatient clinic or contacted by telephone to record any new stroke or death after the index TIA/minor stroke. Further stroke or death was diagnosed according to the hospital discharge record independent of the study team.

Analyses were performed with SPSS statistical package, Version 16.0.

Results
A total of 490 patients were followed for an average of 40.5 months (SD, 10.7 months). Four hundred fifty-nine (93.7%) patients were interviewed in the outpatient clinic and 31 by telephone. The mean age of the patients was 66.3 years (SD, 13.1 years) and 66% were male. Further stroke was identified in 76 (15.5%) patients and 62 (12.7%) patients died during follow-up. The causes of death were ischemic (n=4) or hemorrhagic stroke (n=2), pneumonia (n=16), cancer (n=11), ischemic heart disease (n=4), other causes (n=21), and unknown cause (n=4).

Further stroke and death were stratified by the value of ABCD² in Table 1. Depending on the results of univariate analysis, multivariate Cox regression (Table 2) was performed. An ABCD² score >4 (P<0.001) and previous cerebral vascular disease (P<0.001) were found to be independent predictors of further stroke. The area under the receiver operating characteristic curve was 0.65 (95% CI, 0.58 to 0.71; P<0.001; Figure A). More specifically, an ABCD² score >4 was associated with greater long-term risk of stroke (hazard ratio, 2.27; 95% CI, 1.36 to 3.80; P<0.001; Figure B). As for the predictors of death, previous cerebral
vascular disease ($P=0.007$), smoking ($P=0.002$), and ischemic heart disease ($P<0.001$) were independent predictors. The area under the receiver operating characteristic curve was 0.59 (95% CI, 0.52 to 0.67; $P<0.001$).

The cumulative risk of further stroke of our patients was 7% (95% CI, 5% to 9%) at 12 months, 11% (95% CI, 9% to 13%) at 24 months, 15% (95% CI, 11% to 19%) at 36 months, 17% (95% CI, 13% to 21%) at 48 months, and 17% (95% CI, 13% to 21%) at 54 months.

**Discussion**

Our data extend the usefulness of the ABCD² score to predict stroke or death up to 54 months after a TIA/minor stroke. Most studies confirmed the ABCD² score predicts the immediate risk of stroke. Our report is the first to show that it can predict stroke risk up to 4 years after TIA/minor stroke. Our findings also confirm that in addition to ABCD² score, history of cerebrovascular disease or TIA was an independent predictor of long-term stroke risk consistent with a previous report.³

Limitations of our study included the use of retrospective calculation of the ABCD² score, which might be less predictive than prospective score, although we showed that even retrospective calculation was useful in our study. We excluded patients with atrial fibrillation because the risk of further stroke strongly depended on the use of warfarin, which might be underused in the Chinese population. Risk of stroke in patients with cardioembolic stroke is best predicted by the Cardiac Failure, Hypertension, Age, Diabetes, Stroke (CHADS) score.⁴ Thus, our data support the use of the ABCD² score for stroke risk stratification for noncardioembolic stroke, whereas using CHADS score for cardioembolic stroke. Our study also did not include data of the neuroimaging such as transcranial Doppler and MRI. The addition of the results of neuroimaging may improve the predictive value.⁵

### Table 1: Risk of Further Stroke and Death Stratified According to the ABCD² Score

<table>
<thead>
<tr>
<th>ABCD² Score</th>
<th>Patients, No. (%)</th>
<th>Strokes, No. (%)</th>
<th>Risk (95% CI)*</th>
<th>Death, No. (%)</th>
<th>Risk (95% CI)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1</td>
<td>19 (3.9)</td>
<td>0</td>
<td>0</td>
<td>1 (1.6)</td>
<td>0.10 (0.0–0.33)</td>
</tr>
<tr>
<td>2</td>
<td>36 (7.3)</td>
<td>2 (2.6)</td>
<td>0.06 (0.02–0.13)</td>
<td>1 (1.6)</td>
<td>0.03 (0.0–0.84)</td>
</tr>
<tr>
<td>3</td>
<td>69 (14.1)</td>
<td>7 (9.2)</td>
<td>0.10 (0.03–0.17)</td>
<td>10 (16.1)</td>
<td>0.14 (0.06–0.23)</td>
</tr>
<tr>
<td>4</td>
<td>116 (23.7)</td>
<td>13 (17.1)</td>
<td>0.11 (0.05–0.17)</td>
<td>10 (16.1)</td>
<td>0.86 (0.34–0.14)</td>
</tr>
<tr>
<td>5</td>
<td>114 (23.3)</td>
<td>23 (30.3)</td>
<td>0.20 (0.13–0.28)</td>
<td>16 (25.8)</td>
<td>0.14 (0.07–0.20)</td>
</tr>
<tr>
<td>6</td>
<td>103 (21.0)</td>
<td>20 (26.3)</td>
<td>0.19 (0.12–0.27)</td>
<td>18 (29.0)</td>
<td>0.17 (0.10–0.24)</td>
</tr>
<tr>
<td>7</td>
<td>33 (7.3)</td>
<td>11 (14.5)</td>
<td>0.33 (0.16–0.50)</td>
<td>6 (9.6)</td>
<td>0.18 (0.04–0.32)</td>
</tr>
<tr>
<td>Total</td>
<td>490 (100)</td>
<td>76 (100)</td>
<td>0.16 (0.13–0.19)</td>
<td>62 (100)</td>
<td>0.12 (0.09–0.15)</td>
</tr>
</tbody>
</table>

*Hazard ratio = 1.42 (1.20 to 1.67); $P$ for linear trend across the ABCD² score levels = 0.001.
†Hazard ratio = 1.24 (1.02 to 1.47); $P$ for linear trend across the ABCD² score levels = 0.016.

### Table 2: Multivariate Cox Regression Analysis of Predictors of Long-Term Risk of Further Stroke

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Comparison</th>
<th>Hazard Ratio (95% CI)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk for further stroke</td>
<td>ABCD² score 5–7 versus 0–4</td>
<td>2.27 (1.36–3.80)</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>P-CVD Yes versus no</td>
<td>2.23 (1.36–3.68)</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>P-TIA Yes versus no</td>
<td>1.87 (0.89–3.91)</td>
<td>0.015</td>
</tr>
<tr>
<td>Risk for death</td>
<td>ABCD² score 5–7 versus 0–4</td>
<td>1.68 (0.99–2.85)</td>
<td>0.052</td>
</tr>
<tr>
<td></td>
<td>P-CVD Yes versus no</td>
<td>2.10 (1.22–3.63)</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>IHD Yes versus no</td>
<td>3.47 (1.93–6.42)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Smoker Yes versus no</td>
<td>2.25 (1.36–3.74)</td>
<td>0.002</td>
</tr>
</tbody>
</table>

P-CVD indicates previous cerebrovascular disease; P-TIA, previous TIA; IHD, ischemic heart disease.

![Figure. A](http://stroke.ahajournals.org/)

**Figure.** A, Receiver operating characteristic curves (ROC) for predictive value of ABCD² score to identify individuals at high risk of further stroke. B, Kaplan-Meier curves of patients surviving free from further stroke from time of TIA/minor stroke stratified according to ABCD² score.
In conclusion, the ABCD² score is a useful tool to identify the patients at high risk of long term recurrent stroke after TIA/minor stroke, especially in those with previous history of cerebrovascular disease. Aggressive evaluation and urgent intervention may be required in these patients.

Disclosures
None.

References
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