Stratified, Urgent Care for Transient Ischemic Attack
Results in Low Stroke Rates

Jason Wasserman, PhD; Jeff Perry, MD, MSc; Dar Dowlatshahi, MD, PhD; Grant Stotts, MD; Ian Stiell, MD, MSc; Jane Sutherland, RN; Cheryl Symington, RN; Mukul Sharma, MD, MSc

Background and Purpose—Transient ischemic attack (TIA) is a marker for early risk of stroke. No previous studies have assessed the use of urgent stroke prevention clinics for emergency department (ED) patients with TIA. We hypothesized that an ABCD2-based ED triaging tool for TIA with outpatient management would be associated with lower 90-day stroke rate than that predicted by ABCD2.

Methods—A cohort of prospectively identified patients presenting with symptoms suggestive of TIA seen in 2 tertiary-care EDs. These patients were divided into 3 strata based on their ACBD2 score, and triage targets were set for each stratum. All patients received the same standard of care in the Stroke Clinic regardless of their risk score. Primary outcome was stroke by 90 days of index TIA. Secondary outcomes were subsequent TIA, myocardial infarction, or death.

Results—One-thousand ninety-three patients met the inclusion criteria; 982 patients completed 90-day follow-up and comprised the final cohort. After stratification, 32%, 49%, and 19% of patients were categorized as low-, moderate-, or high-risk, respectively. The overall 90-day risk of stroke in all patients was 3.2%, compared with the ABCD2-predicted risk of 9.2%. Only 1.6% of patients with TIA/minor stroke were admitted from the ED. The risk of subsequent TIA, myocardial infarction, or death by 90 days was 5.5%, 0.1%, and 1.7%, respectively.

Conclusion—Outpatient care in a rapid-access stroke prevention clinic using the ABCD2 score for triage resulted in a low 90-day stroke rate for patients in the ED with TIA. Benefit occurred without requiring admission for most patients. (Stroke. 2010;41:2601-2605.)

Key Words: ABCD2 ■ ischemia ■ recurrent event

Transient ischemic attack (TIA) is a marker for early risk of stroke. Stroke risk is 10% during the 90 days following TIA,1–4 and 25% of all strokes are preceded by a TIA.5 The occurrence of a TIA provides a unique opportunity for stroke prevention. Symptoms of TIA are nonspecific, and false-positive rates in the ED can be as high as 60%.6 Stratification techniques are required to effectively prioritize high-risk patients for urgent management. The ABCD2 score was devised to identify those patients with the highest risk of stroke following TIA; those classified as “high risk” carry a stroke risk of 17.8% at 90 days post TIA.7 Previous studies have suggested improved outcomes by referral to dedicated clinics8,9 or by hospital admission.10,11 Application of these models is limited by resource constraints related to the random nature of events, which may overwhelm capacity and costs associated with inpatient care. No previous studies have assessed the use of urgent stroke prevention clinics for patients in the ED with TIA.

In this study, we identified and followed a prospective cohort of patients presenting to 2 tertiary EDs (combined annual census of 120,000 visits); these patients were diagnosed with TIA and were referred to a comprehensive stroke prevention clinic. We hypothesized that an ABCD2-based ED triaging tool for TIA with outpatient management stratified by risk would be associated with lower 90-day stroke rate than that predicted by the individual patient ABCD2 scores.

Methods

Design and Setting
This prospective cohort study was conducted at the 2 emergency departments of the Ottawa hospital. This is a 1172-bed, tertiary-care, regional stroke referral center with 126,850 emergency visits per year divided between 2 emergency departments. Local ethics board approval was obtained prior to the initiation of this study, and the data were collected by chart review, phone interview, and Stroke Clinic follow-up.

Study Population
We prospectively enrolled adult patients with a final ED diagnosis of TIA between January 2007 and April 2009. Patients were excluded if they fell into 1 of the following categories: diagnosis in emergency
department with a confirmed stroke (ie, neurological deficit >24 hours); decreased level of consciousness (ie, Glasgow Coma Scale score of <15); cause for the deficit was other than TIA (e.g., hypoglycemia, seizure, electrolyte imbalance, or migraine); presentation to the enrolling ED more than 7 days following onset of most recent TIA. A standardized data collection form was completed by the emergency physician at the time of presentation and the following information was prospectively collected: history of neurological symptoms, physical findings, ECG and CT head results, past medical history, medication history and medications started or discontinued in the ED, and ABCD2 score for each patient. The data collection form also included an option to have the patient referred to the Stroke Clinic for follow-up. Only those patients referred to the Stroke Clinic for follow-up were included in the final analysis.

Emergency Department Management

All subjects had blood work taken, including complete blood count, electrolytes, renal and liver function, and international normalized ratio. An electrocardiogram and computed tomography head scan were performed while in the ED. Fasting blood glucose, lipids, carotid Dopplers, and echocardiogram 24-hour Holter monitor were scheduled as outpatient visits. Emergency physicians had the option of consulting the neurology service. They prescribed medications at their own discretion. Recommendations with respect to antiplaquelet and antihypertensive agents were provided by the Stroke Clinic based on current guidelines.

Follow-Up in the Stroke Clinic

In January 2007, a dedicated and comprehensive Stroke Clinic was established at the Ottawa Hospital to provide rapid, standardized assessment and treatment for patients at risk for stroke. Only patients referred to the Stroke Clinic from the ED at the Ottawa Hospital were included in this study. After referral to the Stroke Clinic, patients were triaged based on their ABCD2 score. Patients high risk, moderate risk, or at low risk were scheduled to see a stroke neurologist within 7 days, 7 to 14 days, or more than 14 days of the index TIA, respectively. All patients received the same standard of care regardless of their risk strata.

Primary and Secondary Outcomes

The primary outcome was stroke within 90 days of index TIA. Secondary outcomes were recurrent TIA, myocardial infarction, or death within 90 days. Outcomes were assessed using a validated, standardized telephone questionnaire and chart review. If the occurrence of TIA or stroke was confirmed by a neurologist, it was deemed a subsequent event. Other outcomes were adjudicated by a 3-physician committee, which was blinded to the initial data collection form and ABCD2 score (and its components).

Statistical Analysis

Data were collected and analyzed in SPSS 17 (SPSS Inc, Chicago, Ill). The risk of stroke was calculated for the cohort as a whole and for the each stratum independently. Fisher exact test was used to compare the number of strokes at 90 days with that predicted by the ABCD2 score for each stratum, and for the cohort as a whole. Continuous data are presented as mean±SD where applicable. ABCD2 scores are presented as median with interquartile range.

Results

One-thousand, ninety-one patients were given a final diagnosis of TIA, and 1004 patients (92% of TIA’s) were referred to the Stroke Clinic for assessment. After referral, follow-up data were not available for 22 patients, leaving a total of 982 patients for final analysis (Figure 1).
of cases were discussed with a neurologist while the patient was in the ED, whereas a neurologist was consulted in 5% (n=53) of all cases. Baseline characteristics between patients referred to the Clinic and those not referred were generally very similar; however, some differences were apparent. Specifically, there was no significant difference in the number of females (49.1% compared with 52.8%, P=0.23). However, patients not referred were more likely to be admitted to the hospital (1.6% compared with 15.7%, P<0.0001) for their index event.

On arrival at the ED, 41% and 27% of all patients were already taking an antihypertensive medication or a statin, respectively (Table 2). Thirty-five percent (n=343) of patients were already taking an antiplatelet agent on arrival to the ED, while 90% (n=887) of patients left the ED on at least 1 antiplatelet agent. Of those patients not on an antiplatelet agent at discharge, 50% (n=48) were already taking or were started on Warfarin in the ED. Forty-five percent of patients (n=443) had evidence of carotid stenosis identified by carotid Doppler, while less than 1% of patients (n=5) underwent carotid endarterectomy. None of the patients who underwent carotid endarterectomy were admitted to the hospital during their initial visit. The time between presentation and outpatient carotid Doppler, echocardiogram, or Holter monitoring is shown in Table 3.

The overall stroke risk at 90 days was 3.2% (Figure 2), with almost one third of the strokes occurring within 2 days of the index TIA (Table 4). The risk of subsequent TIA at 90 days was 5.5% (Figure 2), and in contrast to stroke, almost half of all the recurrent events occurred between 30 days and 90 days (Table 4). All-cause mortality was 1.7% at 90 days of index TIA, and in 3 of these patients, stroke was the cause of death. None of the patients not referred to the clinic had a stroke within 90 days of index TIA.

The risk of stroke was significantly lower than that predicted by ABCD2 at 90 days for patients in each risk category and for all patients combined (Table 5). There was no significant difference in the stroke risk between patients in the moderate risk (ABCD2 4 to 5) and high-risk (ABCD2 ≥6) groups (P=0.40). The median ABCD2 score for patients referred to the Clinic was 4 (3, 5) compared with 5 (3, 6) for patients who were not referred. The median ABCD2 score for patients seen by a neurologist in the ED was 5 (4, 6).

**Discussion**

In our study, patients with TIA presenting to a tertiary-care ED were risk stratified and managed urgently by an outpatient Stroke Clinic, yielding a 90-day stroke risk of 3.2%. This risk is one third of that which was predicted by the ABCD2 score for this cohort. We believe that the reduced stroke rate can be attributed to the system of care that combines the ED care and the clinic process.

**Table 1. Characteristics of Patients Presenting to the ED With TIA and Referred to the Stroke Clinic for Management**

<table>
<thead>
<tr>
<th>Age, yr, mean (range)</th>
<th>67 (19–97)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>500 (50.9)</td>
</tr>
<tr>
<td>Admitted to hospital</td>
<td>16 (1.6)</td>
</tr>
<tr>
<td>Risk factors</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>571 (58.1)</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>163 (16.6)</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>84 (8.6)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>195 (19.9)</td>
</tr>
<tr>
<td>Prior stroke</td>
<td>115 (11.7)</td>
</tr>
<tr>
<td>Smoking</td>
<td>131 (13.3)</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>319 (32.5)</td>
</tr>
</tbody>
</table>

**Clinical features**

- Time from index TIA to presentation
  - <24 hours: 660 (67.2)
  - <48 hours: 184 (18.7)
  - <1 week: 132 (13.4)

- Duration of symptoms
  - <1 minute: 18 (1.8)
  - 1–5 minutes: 61 (6.2)
  - 5–9 minutes: 44 (4.5)
  - 10–29 minutes: 138 (14.1)
  - 30–59 minutes: 104 (10.6)
  - ≥60 minutes: 613 (62.4)

- Weakness: 410 (41.8)
- Sensory: 493 (50.2)
- Gait: 225 (22.9)
- Speech: 319 (32.5)

- Visual loss
  - One eye: 54 (5.5)
  - Both eyes: 61 (6.2)
  - Pronator drift: 65 (6.6)
  - Atrial fibrillation on EKG: 45 (4.6)

N (%).

**Table 2. Medications Already Being Taken, Started, or Discontinued in the ED Among Patients Diagnosed With TIA in Our Study**

<table>
<thead>
<tr>
<th>Pharmaceutical</th>
<th>Already Taking</th>
<th>Started in ED</th>
<th>Discontinued in ED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylsalicylic acid</td>
<td>284 (28.9)</td>
<td>429 (43.7)</td>
<td>57 (5.8)</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>69 (7.0)</td>
<td>59 (6.0)</td>
<td>6 (0.6)</td>
</tr>
<tr>
<td>Dipyridamole</td>
<td>26 (2.6)</td>
<td>172 (17.5)</td>
<td>5 (0.5)</td>
</tr>
<tr>
<td>Statin</td>
<td>262 (26.7)</td>
<td>20 (2.0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Antihypertensive</td>
<td>403 (41.0)</td>
<td>16 (1.6)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Ticlodipine</td>
<td>2 (0.2)</td>
<td>3 (0.3)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Warfarin</td>
<td>66 (6.7)</td>
<td>7 (0.7)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

**Table 3. Time Between Event and Outpatient Investigation**

<table>
<thead>
<tr>
<th>Event to Investigation (Days)</th>
<th>Performed Within 2 Weeks (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carotid Doppler (n=831)</td>
<td>12.5±14.1</td>
</tr>
<tr>
<td>Echocardiogram (n=792)</td>
<td>16.8±18.6</td>
</tr>
<tr>
<td>Holter monitor (n=282)</td>
<td>30.7±18.2</td>
</tr>
</tbody>
</table>

Mean±SD.
The ABCD2 score allows for the stratification of patients based on demographic and clinical features to expedite management for those at high risk of stroke.7 The present study is the first to use the ABCD2 score as a prospective triage tool for patients who were diagnosed with TIA in the ED and referred to an outpatient Stroke Clinic. Although all patients received similar medical care in the ED based on an institutional algorithm, the triage tool was used to determine how quickly a patient would be seen in the Stroke Clinic. Investigations and treatments were subsequently catered to each patient by the treating stroke neurologist. Most patients received carotid Doppler imaging within 2 weeks of their index event, a time frame previously identified as having the most significant benefit from endarterectomy.13

Study Strengths
Our cohort was prospectively identified, consecutive, and followed for the occurrence of endpoints through a phone contact system. Medical records were routinely reviewed to ensure that all possible endpoints were collected. Standardized data forms were used along with adjudication of neurological events not identified by a neurologist. It is unlikely that endpoints were missed.

Limitations
Given the observational nature of this study, there are several limitations. First, this cohort was restricted to comparisons with predicted risks. Second, without baseline magnetic resonance imaging or computed tomography angiogram, we were unable to establish whether early strokes were due to progression of initial symptoms or a new event. This information would be relevant for developing interventions that differentiate between stroke prevention and infarct extension.

Table 4. Temporal Distribution of Recurrent Stroke or TIA or MI After Index TIA

<table>
<thead>
<tr>
<th>Event</th>
<th>≤2 Days</th>
<th>&gt;2 Days and ≤7 Days</th>
<th>&gt;7 Days and ≤30 Days</th>
<th>&gt;30 Days and ≤90 Days</th>
<th>All Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>10 (1.0)</td>
<td>9 (0.9)</td>
<td>7 (0.7)</td>
<td>5 (0.5)</td>
<td>31 (3.2)</td>
</tr>
<tr>
<td>TIA</td>
<td>9 (0.9)</td>
<td>11 (1.1)</td>
<td>11 (1.1)</td>
<td>24 (2.4)</td>
<td>55 (5.5)</td>
</tr>
<tr>
<td>MI</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1 (0.1)</td>
<td>1 (0.1)</td>
</tr>
</tbody>
</table>

N (%).

Third, our data do not allow us to distinguish between the impact of ED interventions and the Stroke Clinic interventions. The low stroke rates suggest that outpatient care results in acceptable outcomes. Additional work is needed to identify the relative contribution of the initial management to these outcomes. Finally, we were unable to account for patient compliance with medications prescribed.

The present study is unique in that after ED discharge, patients were followed by a stroke neurologist in a comprehensive and dedicated Stroke Clinic. In contrast, patients in the SOS-TIA study were referred back to their family physician with targets for modifiable risk factors, while in the EXPRESS study, no follow-up details were provided.8,9 In addition to ED treatment algorithms and time-to-stroke–clinic assessment, it is possible that ongoing management from the specialized clinic contributed to lower rates of 90-day stroke; the literature suggests risk factors are often suboptimally managed in the community and can benefit from Stroke Clinic involvement.14,15

Clinical Implications
There is mounting evidence that specialized clinics for managing patients with TIA are associated with a reduced risk of stroke. The EXPRESS and SOS-TIA studies demonstrated that the implementation of rapid-access clinics to assess and initiate treatment following TIA was associated with a 2.1% and 1.2% risk of 90-day stroke, respectively.8,9 In these studies, patients with a suspected TIA were referred primarily from community clinics; in our study, patients originated from tertiary-care EDs, with one third presenting by ambulance, possibly reflecting a more acute population. Furthermore, the median length of symptoms was considerably longer in our study, suggesting a more severe presentation and a higher risk of stroke. Despite these differences, the community-based studies and our study all found significantly lower rates of stroke than would be expected based on ABCD2 scores. This lower event rate likely reflects more rapid, complete management than it did during the time of the ABCD2 study. Notably, our study found no difference in the rate of stroke between the medium- (ABCD2=4 to 5) and high-risk (ABCD2 ≥6) groups; thus, patients at highest risk may have benefitted most from improved management strategies.

An alternate approach for TIA management is brief admission and observation. One study admitted nearly 70% of all patients diagnosed with a TIA and demonstrated an overall 2.4% risk of stroke at 90 days.11 More recently, a Canadian study proposed admitting high-risk TIA patients for rapid evaluation, resulting in a 4.7%, 90-day stroke rate with this approach.10 Conversely, only 3.6% of our high-risk TIA

Table 5. The 90-Day Stroke Rate in our Prospective Cohort Study of 982 TIA Patients Compared With the 90-Day Stroke Rate Predicted by the ABCD2 Score

<table>
<thead>
<tr>
<th></th>
<th>Strokes</th>
<th>% (CI)</th>
<th>Predicted (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABCD ≤4</td>
<td>3</td>
<td>0.9 (0–1.98)</td>
<td>3.1</td>
<td>0.0364</td>
</tr>
<tr>
<td>ABCD 4–5</td>
<td>18</td>
<td>3.8 (2.1–5.58)</td>
<td>9.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>ABCD ≥6</td>
<td>10</td>
<td>5.2 (2.07–8.35)</td>
<td>17.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Combined</td>
<td>31</td>
<td>3.2 (2.07–4.25)</td>
<td>9.1</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Figure 2. Cumulative risk of recurrent stroke or TIA at 2, 7, 30, or 90 days after index TIA.
population was admitted, with a comparatively low 90-day stroke rate of 3.2%. Our study demonstrates that reductions in stroke risk can be achieved without admission to a hospital.

**Research Implications**

An intriguing finding in this study was the discrepancy between the timing of stroke as compared with recurrent TIA: almost one third of all strokes happened within 48 hours of the initial event, whereas almost half of recurrent TIAs occurred between 30 days and 90 days. Recent magnetic resonance imaging studies suggest that early strokes are in fact a progression of the initial event, and it may be the case that a subset of our patients with early stroke represented either fluctuating lacunar syndromes, or infarction following partial large vessel occlusions. Additional studies with baseline computed tomography-angiography and/or magnetic resonance imaging are required to explore this.

**Conclusion**

Our study demonstrated that an ABCD2-based TIA triage rule in a tertiary-care ED with rapid-access Stroke Clinic follow-up resulted in a low 90-day stroke rate. This low rate was achieved without requiring hospital admission in high-risk patients. These results demonstrate that low rates of stroke are achievable without costly hospitalization through a well-organized regional outpatient stroke prevention clinic.

**Sources of Funding**

The work was supported by a grant from CIHR.

**Disclosures**

None.

**References**

Stratified, Urgent Care for Transient Ischemic Attack Results in Low Stroke Rates
Jason Wasserman, Jeff Perry, Dar Dowlatshahi, Grant Stotts, Ian Stiell, Jane Sutherland, Cheryl Symington and Mukul Sharma

Stroke. 2010;41:2601-2605; originally published online October 14, 2010;
doi: 10.1161/STROKEAHA.110.586842
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2010 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the
World Wide Web at:
http://stroke.ahajournals.org/content/41/11/2601

Data Supplement (unedited) at:
http://stroke.ahajournals.org/content/suppl/2013/10/02/STROKEAHA.110.586842.DC1

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org//subscriptions/
脳卒中発生に対する層別化緊急治療は脳卒中発生率を抑制する効果がある

Stratified, Urgent Care for Transient Ischemic Attack Results in Low Stroke Rates

Jason Wasserman, PhD1,3; Jeff Perry, MD, MSc2,3; Dar Dowlatshahi, MD, PhD1,3; Grant Stotts, MD1,3; Ian Stiell, MD2,3, MSc; Jane Sutherland, RN2,3; Cheryl Symington, RN2,3; Mukul Sharma, MD, MSc1,3

1Divisions of Neurology and 2Emergency Medicine, Ottawa Hospital, University of Ottawa, Ottawa, Ontario, Canada; 3Ottawa Hospital Research Institute, University of Ottawa, Ottawa, Ontario, Canada.

Stroke 2010; 41: 2601-2605