Outcomes of Medicare beneficiaries hospitalised with transient ischaemic attack and stratification using the ABCD² score

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ABSTRACT
Background Long-term outcomes for Medicare beneficiaries hospitalised with transient ischaemic attack (TIA) and role of ABCD² score in identifying high-risk individuals are not studied.

Methods We identified 40825 Medicare beneficiaries hospitalised from 2011 to 2014 for a TIA to a Get With The Guidelines (GWTG)-Stroke hospital and classified them using ABCD² score. Proportional hazards models were used to assess 1-year event rates of mortality and rehospitalisation (all-cause, ischaemic stroke, haemorrhagic stroke, myocardial infarction, and gastrointestinal and intracranial haemorrhage) for high-risk versus low-risk groups adjusted for patient and hospital characteristics.

Results Of the 40,825 patients, 35,118 (86%) were high risk (ABCD² ≥ 4) and 5707 (14%) were low risk (ABCD²=0–3). Overall rate of mortality during 1-year follow-up after hospital discharge for the index TIA was 11.7%, 44.3% were rehospitalised for any reason and 3.6% were readmitted due to stroke. Patients with ABCD² score ≥4 had higher mortality at 1 year than not (adjusted HR 1.18, 95% CI 1.07 to 1.30). Adjusted risks for ischaemic stroke, all-cause readmission and mortality/all-cause readmission at 1 year were also significantly higher for patients with ABCD² score ≥4 vs 0–3. In contrast, haemorrhagic stroke, myocardial infarction, gastrointestinal bleeding and intracranial haemorrhage risk were not significantly different by ABCD² score.

Conclusions This study validates the use of ABCD² score for long-term risk assessment after TIA in patients aged 65 years and older. Attentive efforts for community-based follow-up care after TIA are needed for ongoing prevention in Medicare beneficiaries who were hospitalised for TIA.

INTRODUCTION
High prevalence of cardiovascular comorbidities predisposes transient ischaemic attack (TIA) survivors to recurrent adverse events. We aim to describe rates of major adverse events 1 year after hospital discharge among Medicare beneficiaries who experienced a TIA and to examine outcome differences among patients stratified by the ABCD² score. The ABCD² score has been widely used to identify patients at higher risk of acute recurrent stroke after a TIA. However, it has not been used for evaluating long-term risk of other adverse vascular events or mortality after a TIA in Medicare beneficiaries.
### Table 1  Patient and hospital characteristics for Medicare beneficiaries with TIA

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall (N=40825)</th>
<th>ABCD² score 0–3 (N=5707)</th>
<th>ABCD² score ≥4 (N=35118)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age in years, median (IQR)</td>
<td>80.00 (73–86)</td>
<td>80.00 (73–86)</td>
<td>80.00 (73–86)</td>
<td>0.0247</td>
</tr>
<tr>
<td>Sex, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>39.50</td>
<td>41.25</td>
<td>39.22</td>
<td>0.0036</td>
</tr>
<tr>
<td>Race, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2.32</td>
<td>2.14</td>
<td>2.33</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>White</td>
<td>81.87</td>
<td>86.68</td>
<td>81.09</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>1.18</td>
<td>1.12</td>
<td>1.19</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>10.34</td>
<td>6.80</td>
<td>10.92</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>4.29</td>
<td>3.26</td>
<td>4.46</td>
<td></td>
</tr>
<tr>
<td><strong>Medical history, %</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>19.21</td>
<td>20.61</td>
<td>18.99</td>
<td>0.0040</td>
</tr>
<tr>
<td>Prosthetic heart valve</td>
<td>1.85</td>
<td>2.56</td>
<td>1.73</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Previous stroke/TIA</td>
<td>32.07</td>
<td>27.21</td>
<td>32.86</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>CAD/prior MI</td>
<td>31.98</td>
<td>28.40</td>
<td>32.56</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Carotid stenosis</td>
<td>4.59</td>
<td>5.03</td>
<td>4.51</td>
<td>0.0844</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>35.34</td>
<td>11.90</td>
<td>39.15</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>PVD</td>
<td>5.16</td>
<td>4.99</td>
<td>5.19</td>
<td>0.5315</td>
</tr>
<tr>
<td>Hypertension</td>
<td>80.41</td>
<td>75.75</td>
<td>81.16</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Smoker</td>
<td>6.45</td>
<td>5.87</td>
<td>6.55</td>
<td>0.0535</td>
</tr>
<tr>
<td>Dyslipidaemia</td>
<td>51.93</td>
<td>52.50</td>
<td>51.84</td>
<td>0.3577</td>
</tr>
<tr>
<td>Heart failure</td>
<td>9.28</td>
<td>7.59</td>
<td>9.55</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>No of prior hospitalisations, median (IQR)</td>
<td>0.00 (0.00–1.00)</td>
<td>0.00 (0.00–1.00)</td>
<td>0.00 (0.00–1.00)</td>
<td>0.3529</td>
</tr>
<tr>
<td><strong>Discharge status, %</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge home</td>
<td>81.55</td>
<td>89.15</td>
<td>80.32</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Ambulating independently (vs unable or with assistance)</td>
<td>74.24</td>
<td>82.69</td>
<td>72.87</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td><strong>Discharge treatment, %</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Antihypertensive</td>
<td>83.10</td>
<td>79.25</td>
<td>83.73</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Cholesterol-lowering medications</td>
<td>77.20</td>
<td>76.87</td>
<td>77.25</td>
<td>0.5080</td>
</tr>
<tr>
<td>Antithrombotics</td>
<td>95.51</td>
<td>95.92</td>
<td>95.44</td>
<td>0.2728</td>
</tr>
<tr>
<td>Defect-free care*</td>
<td>90.55</td>
<td>91.00</td>
<td>90.48</td>
<td>0.2193</td>
</tr>
<tr>
<td><strong>Hospital characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No of hospital beds, median (IQR)</td>
<td>319 (223–443)</td>
<td>325 (231–484)</td>
<td>318 (222–439)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>No of ischaemic stroke discharges/year, median (IQR)</td>
<td>198.25 (135.09–295.18)</td>
<td>206.82 (143.82–317.19)</td>
<td>196.00 (132.71–293.67)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td><strong>Region</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>West</td>
<td>11.85</td>
<td>9.64</td>
<td>12.21</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>South</td>
<td>30.61</td>
<td>23.80</td>
<td>31.72</td>
<td></td>
</tr>
<tr>
<td>Midwest</td>
<td>19.15</td>
<td>18.50</td>
<td>19.25</td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>38.39</td>
<td>48.06</td>
<td>36.82</td>
<td></td>
</tr>
<tr>
<td>Teaching hospital, %</td>
<td>51.58</td>
<td>53.69</td>
<td>51.24</td>
<td>0.0023</td>
</tr>
<tr>
<td>Primary stroke centre certification, %</td>
<td>44.79</td>
<td>42.63</td>
<td>45.14</td>
<td>0.0004</td>
</tr>
</tbody>
</table>

Continued
estimates. For readmission outcomes, estimates were reported from the cumulative incidence functions. The cumulative instance was reported to describe the observed rates of outcomes. For mortality outcomes, the log-rank test was used to compare the difference between ABCD$^2$ $\geq 4$ and 0–3, and for readmission outcomes, the Fine-Gray model was used to account for the competing risk of mortality to readmission. Multivariable proportional hazard (Cox) models were constructed to examine the association of outcomes with ABCD$^2$ score and adjusted for patient and hospital characteristics. Robust SE estimates were used to account for within-hospital clustering.

Statistical analyses were performed using SAS software V.9.4 (SAS Institute). P values are based on two-sided tests, with $p<0.05$ considered statistically significant.

RESULTS
Of 40,825 patients with an index TIA admission, 35,118 (86%) were high risk and 5,707 (14%) were low risk. Characteristics for patients with a TIA overall and by ABCD$^2$ score categories are described in table 1. Median age of Medicare beneficiaries with a TIA was 80 years, 81.9% were white and 60.5% were women. Discharge home from the hospital occurred for 81.6% of patients (table 1).

During 1-year follow-up after hospital discharge for the index TIA, 11.7% died and 44.3% were rehospitalised for any reason (table 2, online supplemental figure S1). After risk adjustment, patients with an ABCD$^2$ score $\geq 4$ had a higher risk of 1-year ischaemic stroke (3.7% vs 2.7%; HR 1.25 (95% CI 1.04 to 1.50), all-cause), readmissions (45.1% vs 39.8%; HR 1.08 (1.03 to 1.14)) and mortality (12.0% vs 9.5%; HR 1.18 (1.07 to 1.30)) than patients with an ABCD$^2$ score of 0–3. Additionally, patients with an ABCD$^2$ score $\geq 4$ have a higher hazard of each composite endpoint (mortality/ischaemic stroke, mortality/all-cause rehospitalisation and mortality/major vascular event) at 1 year. When stratified by ABCD$^2$ score, there was no difference in the observed rates of 1-year myocardial infarction, haemorrhagic stroke, gastrointestinal bleed or major vascular events.

DISCUSSION
The contemporary data presented here on occurrence of adverse events within 1 year after hospitalisation for TIA in Medicare beneficiaries will be instructive for targeting preventive efforts. We also demonstrated that the ABCD$^2$ score can be used to identify patients at higher risk for ischaemic stroke, all-cause rehospitalisation and mortality even at 1 year following index TIA.

Major changes in the management of TIA have occurred in recent years, including urgent management in specialised units and implementation of rapid investigation and algorithms for routine use of preventive...
treatments.6–9 However, patients with a higher burden of cardiovascular comorbidities continue to suffer from high cardiovascular mortality or rehospitalisation following TIA.1 3 10–12

A previous study of Medicare beneficiaries admitted with TIA at GWTG-Stroke-participating hospitals from 2003 to 2008 showed that patients with TIA at higher risk of adverse outcomes were actually less likely to receive guideline-recommended care.3

Previous studies have shown the association between higher ABCD² score and increased short-term risk of stroke after TIA.5 Validation studies have shown conflicting results, and the ABCD² scoring system has not been evaluated for predicting long-term risk.2 10–12 Our study validates use of the ABCD² score for long-term risk assessment in a large, US national patient population of patients aged 65 years and older after TIA.

This study has several limitations. We analysed data for Medicare fee-for-service beneficiaries who presented to the hospitals participating voluntarily in a quality improvement initiative, which will influence generalisability of the results. It is worth noting that the observed rate of 1-year mortality in our cohort is significantly higher than what was reported in some of the previous studies, likely due to the older population in our cohort. In a study by Olson et al, 3.8% of subjects died within 1 year of hospital discharge after TIA, but the median age was 69 years for patients with TIA in that study compared with 80 years in our study.11 Another study by Amarenco et al estimated 1-year risk of death from any cause in patients with a TIA at 1.8%.10 Again, the average age of patients in this study was 66.1 years compared with 80 years in our study. Diagnosis of TIA was based on standard clinical criteria, and misclassification is possible. Outcomes were identified using only Medicare administrative claims data, although overall accuracy of such approach is high.14 We were also unable to assess potential effects of differential postdischarge care on adverse outcomes.

**SUMMARY AND CONCLUSION**

Enhanced planning of postdischarge care and community-based follow-up may be warranted to ensure continued efforts to prevent adverse events after a hospitalisation for TIA in Medicare beneficiaries. ABCD² score on admission for Medicare beneficiaries with TIA can be used to identify a vulnerable group of patients at risk for ischaemic stroke, rehospitalisation and death.

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**Contributors** SS interpreted the results and drafted the manuscript. LL had full access to all of the data in the study, analysed the data and takes responsibility for the integrity of the data and the accuracy of the data analysis. DB, SJ, EES, DLB, GCF, NDK and EP contributed to the critical revision of the manuscript for important intellectual content. JPB designed and conceptualised the study and contributed to the critical revision of the manuscript for important intellectual content. All authors have read and approved the final manuscript.

**Funding** This study was funded by AstraZeneca.

**Competing interests** DB, SJ, NDK: employees of AstraZeneca. GCF: research: PCORI; consultant: Janssen, Medtronic and St Jude Medical. AHA GWTG Steering Committee. EES: AHA GWTG Steering Committee. EP: AHA GWTG Data Analytic Center. DLB: Advisory Board: Cardax, Elsevier Practice Update Cardiology, Medscape Cardiology, Regado Biosciences; Board of Directors: Boston VA Research Institute, Society of Cardiovascular Patient Care, TobieSoft; Chair: American Heart Association Quality Oversight Committee; Data Monitoring Committees: Baim Institute for Clinical Research (formerly Harvard Clinical Research Institute, for the PORTICO trial; funded by St. Jude Medical, now Abbott), Cleveland Clinic, Duke Clinical Research Institute, Mayo Clinic, Mount Sinai School of Medicine, Population Health Research Institute; Honoraria: American College of Cardiology (Senior Associate Editor, Clinical Trials and News, ACC.org; Vice-Chair, ACC Accreditation Committee), Baim Institute for Clinical Research (formerly Harvard Clinical Research Institute; RE-DUAL PCI Clinical Trial Steering Committee funded by Boehringer Ingelheim), Belvoir Publications (Editor in Chief, Harvard Heart Letter), Duke Clinical Research Institute (Clinical Trial Trial Steering Committees), HMP Global (Editor in Chief, Journal of Invasive Cardiology), Journal of the American College of Cardiology (Guest Editor; Associate Editor), Population Health Research Institute (for the COMPASS Operations Committee, Publications Committee, Steering Committee, and USA national co-leader, funded by Bayer), Slack Publications (Chief Medical Editor, Cardiology Today’s Intervention), Society of Cardiovascular Patient Care (Secretary/ Treasurer), WebMD (CME Steering Committees); Other: Clinical Cardiology (Deputy Editor), NCDR-ACTION Registry Steering Committee (Chair), VA CART Research and Publications Committee (Chair); Research Funding: Abbott, Amarin, Amgen, AstraZeneca, Bayer, Boehringer Ingelheim, Bristol-Myers Squibb, Chiesi, Eisai, Ethicon, Forest Laboratories, Idorsia, Ironwood, Ischemix, Lilly, Medtronic, PhaseBio, Pfizer, Regeneron, Roche, Sanofi Aventis, Synaptic, The Medicines Company; Royalties: Elsevier (Editor, Cardiovascular Intervention: A Companion to Braunwald’s Heart Disease); site co-investigator: Biotronik, Boston Scientific, St. Jude Medical (now Abbott), Svelte; Trustee: American College of Cardiology; unfunded research: FlowCo, Merck, Plix Pharma, Takeda.

**Patient consent for publication** Not required.

**Provenance and peer review** Not commissioned; externally peer reviewed.

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**REFERENCES**