


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

Shreyansh Shah ¹, Li Liang,² Durgesh Bhandary,³ Saga Johansson,³ Eric E Smith,⁴ Deepak L Bhatt,⁵ Gregg C Fonarow,⁶ Naeem D Khan,³ Eric Peterson,² Janet Prvu Bettger²

To cite: Shah S, Liang L, Bhandary D, *et al.* Outcomes of Medicare beneficiaries hospitalised with transient ischaemic attack and stratification using the ABCD² score. *Stroke & Vascular Neurology* 2021;**6**: e000372. doi:10.1136/svn-2020-000372

► Additional material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/svn-2020-000372>).

Received 27 March 2020
Revised 2 September 2020
Accepted 2 October 2020
Published Online First
4 November 2020



© Author(s) (or their employer(s)) 2021. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

Correspondence to

Dr Shreyansh Shah;
Shreyansh.Shah@duke.edu

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 40 825 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.¹ 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.² However, it has not been used for evaluating long-term risk of other adverse vascular events or mortality after a TIA in Medicare beneficiaries.

MATERIALS AND METHODS AND RESULTS

Data for patients with an index TIA admission at a participating Get With The Guidelines (GWTG)-Stroke hospitals from 2011 to 2014 were linked with Medicare inpatient claims. Details of the GWTG-Stroke design, linkage with Centres for Medicare and Medicaid Services (CMS) claims data and ascertainment of TIA cases have been previously published.³ Participating hospitals receive either human research approval to enrol cases without individual patient consent under the common rule or a waiver of authorisation by their institutional review board (IRB). The Duke Clinical Research Institute serves as the data analysis centre for the aggregate deidentified data and the IRB at XXXX University has approved this study. Calculation of the ABCD² score is described in detail in the online supplemental file. ABCD² ≥4 vs 0–3 threshold was used to risk stratify, as this has been shown to be predictive of higher risk of stroke in previous TIA studies.^{4,5} Baseline patient and hospital characteristics were obtained from GWTG-Stroke and summarised using standard descriptive statistical techniques. All patients discharged in 2011–2013 were followed up for at least 1 year and Medicare inpatient claim data were used to determine the 1-year clinical endpoints. Patients discharged in 2014 were censored at the earlier date of death or the end of study date of 31 December 2014. The median follow-up time for all 2014 discharges was 184 days. Event rates for 1-year mortality and composite of readmission or mortality outcomes were provided using Kaplan-Meier

Table 1 Patient and hospital characteristics for Medicare beneficiaries with TIA

Variable	Overall (N=40825)	ABCD ² score 0–3 (N=5707)	ABCD ² score ≥4 (N=35118)	P value
Demographics				
Age in years, median (IQR)	80.00 (73–86)	80.00 (73–86)	80.00 (73–86)	0.0247
Sex, %				
Male	39.50	41.25	39.22	0.0036
Race, %				
Other	2.32	2.14	2.33	<0.0001
White	81.87	86.68	81.09	
Asian	1.18	1.12	1.19	
Black	10.34	6.80	10.92	
Hispanic	4.29	3.26	4.46	
Medical history, %				
Atrial fibrillation	19.21	20.61	18.99	0.0040
Prosthetic heart valve	1.85	2.56	1.73	<0.0001
Previous stroke/TIA	32.07	27.21	32.86	<0.0001
CAD/prior MI	31.98	28.40	32.56	<0.0001
Carotid stenosis	4.59	5.03	4.51	0.0844
Diabetes mellitus	35.34	11.90	39.15	<0.0001
PVD	5.16	4.99	5.19	0.5315
Hypertension	80.41	75.75	81.16	<0.0001
Smoker	6.45	5.87	6.55	0.0535
Dyslipidaemia	51.93	52.50	51.84	0.3577
Heart failure	9.28	7.59	9.55	<0.0001
No of prior hospitalisations, median (IQR)	0.00 (0.00–1.00)	0.00 (0.00–1.00)	0.00 (0.00–1.00)	0.3529
Discharge status, %				
Discharge home	81.55	89.15	80.32	<0.0001
Ambulating independently (vs unable or with assistance)	74.24	82.69	72.87	<0.0001
Discharge treatment, %				
Antihypertensive	83.10	79.25	83.73	<0.0001
Cholesterol-lowering medications	77.20	76.87	77.25	0.5080
Anti-thrombotics	95.51	95.92	95.44	0.2728
Defect-free care*	90.55	91.00	90.48	0.2193
Hospital characteristics				
No of hospital beds, median (IQR)	319 (223–443)	325 (231–484)	318 (222–439)	<0.0001
No of ischaemic stroke discharges/year, median (IQR)	198.25 (135.09–295.18)	206.82 (143.82–317.19)	196.00 (132.71–293.67)	<0.0001
Region				
West	11.85	9.64	12.21	<0.0001
South	30.61	23.80	31.72	
Midwest	19.15	18.50	19.25	
Northeast	38.39	48.06	36.82	
Teaching hospital, %	51.58	53.69	51.24	0.0023
Primary stroke centre certification, %	44.79	42.63	45.14	0.0004

Continued

Table 1 Continued

Variable	Overall (N=40825)	ABCD ² score 0–3 (N=5707)	ABCD ² score ≥4 (N=35118)	P value
Rural location, %	6.10	4.71	6.33	<0.0001

*Defect-free care is a global quality of care metric. Details provided in the online supplemental material.

CAD, coronary artery disease; HF, heart failure; MI, myocardial infarction; PVD, peripheral vascular disease; TIA, transient ischaemic attack.

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 ABCD² ≥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 ABCD² 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 40825 patients with an index TIA admission, 35118 (86%) were high risk and 5707 (14%) were low risk. Characteristics for patients with a TIA overall and by ABCD² 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 ABCD² score ≥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 ABCD² score of 0–3. Additionally, patients with an ABCD² score ≥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 ABCD² 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 ABCD² 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

Table 2 Event rates, unadjusted and adjusted 1-year outcomes comparing TIA patients with ABCD² ≥4 and 0–3

Outcomes 1 year after TIA	Overall	ABCD ² 0–3	ABCD ² ≥4	Unadjusted HR (95% CI)	Adjusted* HR (95% CI)
Ischaemic stroke	3.6%	2.7%	3.7%	1.37 (1.15 to 1.64)	1.25 (1.04 to 1.50)
Haemorrhagic stroke	0.5%	0.5%	0.5%	0.94 (0.63 to 1.42)	0.97 (0.63 to 1.47)
Myocardial infarction	1.6%	1.5%	1.6%	1.04 (0.82 to 1.32)	0.88 (0.68 to 1.13)
Gastrointestinal bleed	2.2%	2.0%	2.2%	1.12 (0.90 to 1.38)	1.05 (0.84 to 1.31)
Major vascular events†	5.6%	4.7%	5.7%	1.21 (1.06 to 1.39)	1.10 (0.96 to 1.27)
All-cause readmission	44.3%	39.8%	45.1%	1.18 (1.12 to 1.24)	1.08 (1.03 to 1.14)
All-cause mortality	11.7%	9.5%	12.0%	1.28 (1.16 to 1.41)	1.18 (1.07 to 1.30)
Composite mortality or ischaemic stroke	14.6%	12.1%	15.0%	1.26 (1.16 to 1.38)	1.16 (1.07 to 1.27)
Composite mortality or major vascular event†	15.9%	13.4%	16.3%	1.24 (1.14 to 1.35)	1.14 (1.05 to 1.24)
Composite mortality or all-cause rehospitalisation	47.2%	42.2%	48.1%	1.20 (1.14 to 1.26)	1.10 (1.05 to 1.16)

*Covariates used in adjusted models listed in the online supplemental file.

†Major vascular event includes rehospitalisations for ischaemic stroke, haemorrhagic stroke or myocardial infarction. TIA, transient ischaemic attack.

treatments.^{6–9} However, patients with a higher burden of cardiovascular comorbidities continue to suffer from high mortality or rehospitalisation following TIA.^{1 3 10–12} A previous study of Medicare beneficiaries admitted with TIA at GWGTG-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 13} 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.

Author affiliations

¹Department of Neurology, Duke University School of Medicine, Durham, North Carolina, USA

²Duke Clinical Research Institute, Durham, North Carolina, USA

³AstraZeneca UK Ltd, Cambridge, UK

⁴Hotchkiss Brain Institute and Department of Clinical Neurosciences, University of Calgary, Calgary, Alberta, Canada

⁵Division of Cardiology, Brigham and Women's Hospital, Boston, Massachusetts, USA

⁶Division of Cardiology, Ronald Reagan UCLA Medical Center, Los Angeles, California, USA

Twitter Shreyansh Shah @Shree_Stroke

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 GWGTG Steering Committee. EES: AHA GWGTG Steering Committee. EP: AHA GWGTG 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, TobeSoft; 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 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, Amgen, 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, PLX Pharma, Takeda.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

Shreyansh Shah <http://orcid.org/0000-0001-8441-6326>

REFERENCES

- 1 Yousufuddin M, Young N, Keenan L, *et al*. Five-year mortality after transient ischemic attack: focus on cardiometabolic comorbidity and hospital readmission. *Stroke* 2018;49:730–3.
- 2 Fothergill A, Christianson TJH, Brown RD, *et al*. Validation and refinement of the ABCD² score: a population-based analysis. *Stroke* 2009;40:2669–73.
- 3 O'Brien EC, Zhao X, Fonarow GC, *et al*. Quality of care and ischemic stroke risk after hospitalization for transient ischemic attack: findings from get with the Guidelines-Stroke. *Circ Cardiovasc Qual Outcomes* 2015;8:S117–24.
- 4 Amarenco P, Lavallée PC, Monteiro Tavares L, *et al*. Five-Year risk of stroke after TIA or minor ischemic stroke. *N Engl J Med* 2018;378:2182–90.
- 5 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.



- 6 Olivot J-M, Wolford C, Castle J, *et al.* Two aces: transient ischemic attack work-up as outpatient assessment of clinical evaluation and safety. *Stroke* 2011;42:1839–43.
- 7 Rothwell PM, Giles MF, Chandratheva A, *et al.* Mehta Z and early use of existing preventive strategies for stroke S. effect of urgent treatment of transient ischaemic attack and minor stroke on early recurrent stroke (express study): a prospective population-based sequential comparison. *Lancet* 2007;370:1432–42.
- 8 Sanders LM, Srikanth VK, Jolley DJ, *et al.* Monash transient ischemic attack triaging treatment: safety of a transient ischemic attack mechanism-based outpatient model of care. *Stroke* 2012;43:2936–41.
- 9 Wasserman J, Perry J, Dowlatshahi D, *et al.* Stratified, urgent care for transient ischemic attack results in low stroke rates. *Stroke* 2010;41:2601–5.
- 10 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.
- 11 Olson DM, Cox M, Pan W, *et al.* Peterson ED and adherence evaluation of acute ischemic Stroke-Longitudinal Ar. death and rehospitalization after transient ischemic attack or acute ischemic stroke: one-year outcomes from the adherence evaluation of acute ischemic stroke-longitudinal registry. *J Stroke Cerebrovasc Dis* 2013;22:e181–8.
- 12 Brown DL, Lisabeth LD, Roychoudhury C, *et al.* Recurrent stroke risk is higher than cardiac event risk after initial stroke/transient ischemic attack. *Stroke* 2005;36:1285–7.
- 13 Giles MF, Rothwell PM. Systematic review and pooled analysis of published and unpublished validations of the ABCD and ABCD2 transient ischemic attack risk scores. *Stroke* 2010;41:667–73.
- 14 Goldstein LB. Accuracy of ICD-9-CM coding for the identification of patients with acute ischemic stroke: effect of modifier codes. *Stroke* 1998;29:1602–4.