SVN Stroke and Vascular Neurology

Outcomes of Medicare beneficiaries hospitalised with transient ischaemic attack and stratification using the ABCD^2 score

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To cite: Shah S, Liang L, Bhandary D, *et al*. Outcomes of Medicare beneficiaries hospitalised with transient ischaemic attack and stratification using the ABCD^2 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

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ABSTRACT

Background Long-term outcomes for Medicare beneficiaries hospitalised with transient ischaemic attack (TIA) and role of ABCD^2 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 ABCD^2 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 (ABCD^2 ≥4) and 5707 (14%) were low risk (ABCD^2=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 ABCD^2 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 ABCD^2 score ≥4 vs 0–3. In contrast, haemorrhagic stroke, myocardial infarction, gastrointestinal bleeding and intracranial haemorrhage risk were not significantly different by ABCD^2 score.

Conclusions This study validates the use of ABCD^2 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 ABCD^2 score. The ABCD^2 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 ABCD^2 score is described in detail in the online supplemental file. ABCD^2 ≥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=40 825)	ABCD^2 score 0–3 (N=5707)	ABCD^2 score ≥4 (N=35 118)	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
Antithrombotics	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=40 825)	ABCD^2 score 0–3 (N=5707)	ABCD^2 score ≥4 (N=35 118)	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 ABCD^2 ≥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 5707 (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 ≥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 >=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

Table 2 Event rates, unadjusted and adjusted 1-year outcomes comparing TIA patients with ABCD^2 ≥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 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 ABCD^2 score and increased short-term risk of stroke after TIA.[5] Validation studies have shown conflicting results, and the ABCD^2 scoring system has not been evaluated for predicting long-term risk.[2 13] Our study validates use of the ABCD^2 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. ABCD^2 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, 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, 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, PLx Pharma, Takeda.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

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Outcomes of Medicare Beneficiaries Hospitalized with Transient Ischemic Attack and stratification using the ABCD^2 Score

(TIA outcomes for Medicare Beneficiaries)

ONLINE SUPPLEMENT

Supplemental Methods

Supplementary Figure S1

Shah S, *et al. Stroke Vasc Neurol* 2020;0:1–5. doi: 10.1136/svn-2020-000372

Supplemental Methods

M1. Calculating the ABCD^2 score from GWTG data

ABCD^2 score is a risk assessment tool typically used for short-term stroke risk after transient ischemic attack (TIA). The score requires data on age, systolic and diastolic blood pressure, stroke symptoms, duration of the TIA, and history of diabetes. Points are assigned for different values for the different variables as indicated below and then summed across the five independent factors. Higher ABCD^2 scores are associated with greater risk of stroke with a recommendation to change clinical practice for patients with a score of four or greater.

Defining the ABCD^2 score

	Age	Blood Pressure*	Clinical Features† – Stroke Symptoms	TIA Duration	Diabetes
no point	<60 years	normal	no speech disturbance and no unilateral (one-sided) weakness	<10 minutes	no diabetes
1 point	≥60 years	raised (SBP≥140 or DBP≥90 mmHg)	speech disturbance present but no unilateral weakness	10–59 minutes	diabetes present
2 points	–	–	unilateral weakness	≥60 minutes	–

*For blood pressure, if a patient had systolic BP>=140 OR diastolic BP>=90, s/he has 1 point.
†For clinical features, GWTG-Stroke collected the variables Weakness/Paresis, Aphasia or language disturbance.

In 2011-2014 GWTG-Stroke/CMS linked data for TIA patients population (N=77,819), we found

- Age had complete data,
- Blood pressure had 22.9% missing,
- Stroke symptoms had 20.0% missing,
- TIA duration had 53.9% missing
- History of diabetes had 0.5% missing.

Total ABCD^2 score had 61% missing. However, the missing for ABCD^2 score ≥ 4 stratification was 47.5%. For example, if a patient has a score ≥ 4 using age, blood pressure, symptoms and history of diabetes, regardless of missing or value of TIA duration, we assigned "ABCD^2 score ≥ 4 = Yes." Thus the final study sample with complete data available to assign ABCD^2 score ≥ 4 or < 4 categories included 40,825 patients.

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M2. Covariates in adjusted models

In the adjusted models, the covariates adjusted for include patient demographics (age, female sex, race-ethnicity Caucasians, Black, Hispanic, Asian and others), and patient medical history (atrial fibrillation/flutter, prosthetic heart valve, previous stroke/TIA, coronary artery disease or prior MI, carotid stenosis, peripheral vascular disease, hypertension, dyslipidemia, heart failure and smoking), number of hospitalization within 6 months prior to index, arrived at off-hours, EMS, in stroke unit, tPA use, DVT by day 2, discharge medications – antihypertensive, lipid lowering, antithrombotic, smoking cessation, and hospital characteristics (rural vs. urban setting, number of beds, teaching hospital, region, primary stroke center (PSC), annual volume of ischemic stroke and IV tPA). These covariates were either complete or had small missing (<3%) except and simple imputation was used to handle missing. For medical histories missing was imputed to no, for other variables missing was imputed to dominant level.

M3. Defect-free Care

Defect-free care is a binary metric of global quality of care.[1] It is defined as the proportion of patients who had received all of the interventions that they were eligible for.

M4. Competing Interests

Shah, Liang, Bettger: None
Bhandary, Johansson, Khan: Employees of AstraZeneca
Fonarow: Research: PCORI; Consultant: Janssen, Medtronic, and St Jude Medical. AHA GWTG Steering Committee
Smith: AHA GWTG Steering Committee
Peterson: AHA GWTG Data Analytic Center
Bhatt: 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, 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, PLx Pharma, Takeda.

Supplementary Figure S1

One-year outcomes versus days after discharge from the index hospitalization for TIA according to $ABCD^2$ score.

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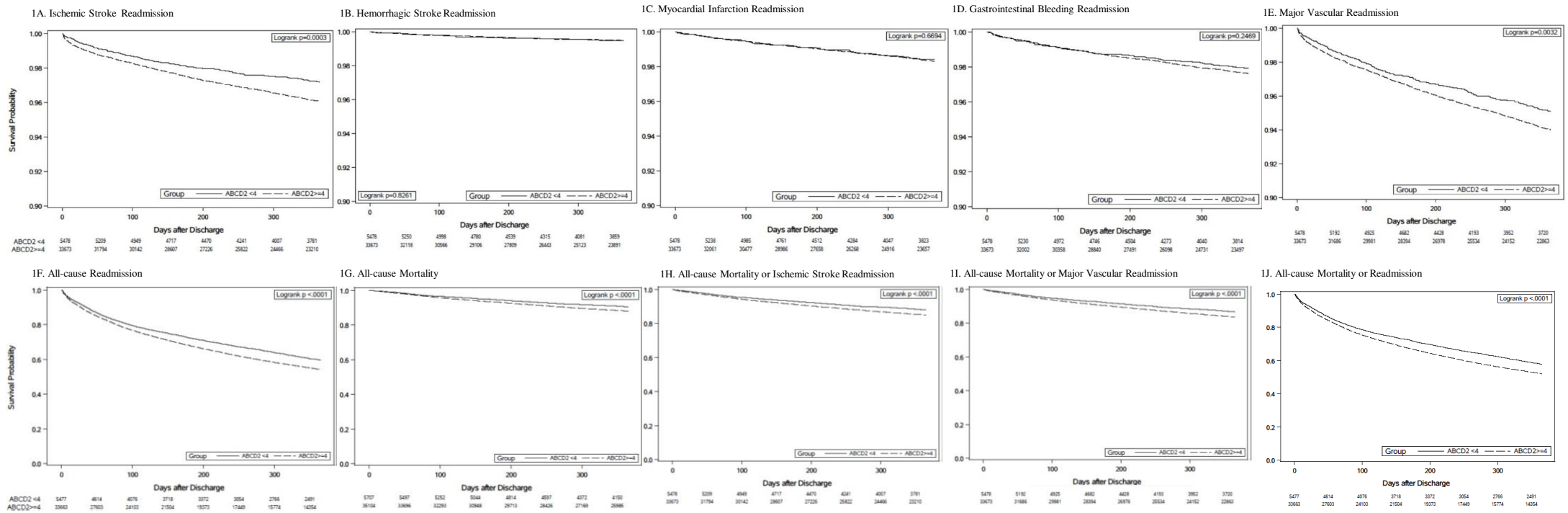

Supplementary Figure S1: One-year outcomes versus days after discharge from the index hospitalization for TIA according to ABCD^2 score.