

SUPPLEMENTAL MATERIAL

Association between CHADS₂, CHA₂DS₂-VASc, ATRIA, and Essen stroke risk scores and functional outcomes in acute ischemic stroke patients who received endovascular thrombectomy

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Table S1. Univariate logistic regression analysis of the risk of an unfavorable outcome.

Variables	Unadjusted	<i>p</i> -value
	OR (95% CI)	
Age, per-1-year increase,	1.045 (1.027-1.062)	<0.001
Female sex	1.060 (0.716-1.569)	0.770
BMI, per-1-kg/m ² increase	0.930 (0.885-0.977)	0.004
Vascular risk factors		
Hypertension	1.068 (0.681-1.677)	0.774
Diabetes mellitus	3.027 (2.011-4.555)	<0.001
Hypercholesterolemia	1.023 (0.691-1.516)	0.909
Current smoking	0.577 (0.342–0.982)	0.039
eGFR < 60 mL/min	2.640 (1.766-3.948)	<0.001
Comorbidities		
Atrial fibrillation	1.464 (0.987-2.170)	0.058
Heart failure	2.275 (1.092-4.740)	0.028
Coronary disease	0.613 (0.399-0.942)	0.026
Peripheral artery disease	1.833 (0.615-5.460)	0.277
Previous infarction	1.687 (1.045-2.724)	0.032
Previous hemorrhage	1.709 (0.667-4.786)	0.264
Medication before admission		
Prior antiplatelet therapy	1.252 (0.823-1.903)	0.294
Prior anticoagulant therapy	0.635 (0.374-1.077)	0.102

Prior statin therapy	1.075 (0.705-1.640)	0.736
Initial NIHSS score, per-1-score increase	1.172 (1.127-1.219)	<0.001
Treatment		
tPA		
-IA thrombolysis alone	Reference	
-Combined IV/IA thrombolysis*	0.566 (0.378-0.846)	0.006
Stent-retriever alone	0.501 (0.317-0.794)	0.003
Aspiration alone	3.434 (1.250-9.437)	0.017
Combined stent-retriever/ aspiration**	0.638 (0.389-1.075)	0.104
Number of stent-retriever passes, per-1-passes increase	1.224 (1.092-1.372)	0.001
Onset to puncture, per-1-min increase	1.000 (1.000-1.001)	0.793
LNT-to-puncture time (within 6hrs)	1.341 (0.567-1.745)	0.542
Stroke etiology		
Cardioembolic	reference	
Large artery atherosclerosis	0.688 (0.394-1.202)	0.189
Undetermined or others	0.940 (0.598-1.479)	0.790
Image finding after EVT		
mTICI 2b-3	0.135 (0.067-0.272)	<0.001
Hemorrhagic transformation	8.942 (4.308-18.558)	<0.001
Stroke risk score		
CHA ₂ DS ₂ VASc score	1.386 (1.213-1.583)	<0.001
CHADS ₂ score	1.731 (1.409-2.127)	<0.001
ATRIA score	1.162 (1.096-1.233)	<0.001

Essen score

1.289 (1.111-1.495)

0.001

OR, odd ratio; CI, confidence interval; BMI, body mass index; eGFR, estimated glomerular filtration rate; National Institutes of Health Stroke Scale, NIHSS; tPA, tissue plasminogen activator; IA, intra-arterial; IV, intravenous; LNT, last normal time; EVT, endovascular thrombectomy; mTICI, modified thrombolysis in cerebral infarction

* administration of tissue plasminogen activator prior to endovascular thrombectomy

**cases in which stent retriever and aspiration were performed simultaneously or sequentially

Table S2. Multivariate analysis for stroke risk score correlated with the unfavorable outcome among 404 patients with EVT (Model 2)

Variables	CHADS₂		CHA₂DS₂VASc		ATRIA		Essen	
	OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value
BMI, per 1-kg/m ² increase	0.947 (0.896-1.002)	0.060	0.978 (0.921-1.038)	0.457	0.974 (0.918-1.034)	0.386	0.953 (0.899-1.010)	0.106
Current smoking	0.947 (0.504-1.781)	0.867	0.969 (0.515-1.826)	0.923	0.951 (0.503-1.800)	0.878	0.692 (0.364-1.315)	0.261
eGFR < 60 mL/min	1.472 (0.884-2.451)	0.138	1.709 (1.055-2.767)	0.029	1.657 (0.997-2.753)	0.051	1.523 (0.919-2.522)	0.103
Atrial fibrillation	0.826 (0.504-1.356)	0.451	0.855 (0.523-1.398)	0.532	0.886 (0.544-1.443)	0.627	0.834 (0.509-1.367)	0.472
Heart failure	1.134 (0.453-2.842)	0.788	1.266 (0.492-3.255)	0.625	1.781 (0.755-4.204)	0.187	1.874 (0.798-4.397)	0.149
Coronary disease	0.394 (0.236-0.656)	<0.001	0.414 (0.250-0.687)	<0.001	0.426 (0.258-0.706)	<0.001	0.304 (0.170-0.545)	<0.001
Previous infarction	1.416 (0.802-2.499)	0.230	1.427 (0.812-2.509)	0.217	1.167 (0.606-2.250)	0.644	1.415 (0.802-2.496)	0.231
Initial NIHSS score, per 1-score increase	1.165 (1.118-1.214)	<0.001	1.161 (1.115-1.210)	<0.001	1.160 (1.114-1.209)	<0.001	1.162 (1.115-1.210)	<0.001
Risk scoring score								
Per-1-point increase	1.678 (1.327-2.121)	<0.001	1.257 (1.073-1.471)	0.005	1.091 (1.013-1.176)	0.021	1.350 (1.096-1.664)	0.005

OR, odd ratio; CI, confidence interval; BMI, body mass index; eGFR, estimated using the glomerular filtration rate; National Institutes of Health Stroke Scale, NIHSS

Table S3. Multivariate analysis for stroke risk score correlated with the unfavorable outcome among successful recanalization patients (Model 1)

Variables	CHADS ₂		CHA ₂ DS ₂ VASc		ATRIA		Essen	
	OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value
BMI, per-1-kg/m ² increase	0.994 (0.885-1.116)	0.913	1.017 (0.910-1.136)	0.766	1.023 (0.913-1.146)	0.695	1.011 (0.902-1.131)	0.857
eGFR < 60 mL/min	1.327 (0.517-3.406)	0.557	1.526 (0.610-3.820)	0.367	1.315 (0.505-3.426)	0.575	1.633 (0.647-4.121)	0.299
Heart failure	0.718 (0.145-3.546)	0.684	0.840 (0.161-4.376)	0.836	1.301 (0.321-5.278)	0.713	1.668 (0.432-6.432)	0.458
Initial NIHSS score, per 1-score increase	1.212 (1.112-1.320)	<0.001	1.213 (1.113-1.322)	<0.001	1.120 (1.101-1.308)	<0.001	1.218 (1.118-1.327)	<0.001
IV thrombolysis								
IA thrombolysis alone	Reference		Reference		Reference		Reference	
Combined IA/IV thrombolysis*	0.222 (0.093-0.532)	<0.001	0.213 (0.089-0.510)	<0.001	0.207 (0.086-0.497)	<0.001	0.195 (0.082-0.463)	<0.001
IA thrombolysis								
Stent-retriever alone	0.709 (0.218-2.304)	0.567	0.708 (0.217-2.309)	0.567	0.689 (0.212-2.244)	0.536	0.670 (0.207-2.168)	0.504
Aspiration alone	1.545 (0.578-2.516)	0.478	1.347 (0.375-2.248)	0.589	1.257 (0.853-2.221)	0.322	1.321 (0.322-2.325)	0.477
Number of stent-retriever passes, per-1-passes increase	1.302 (0.972-1.743)	0.077	1.299 (0.968-1.744)	0.086	1.328 (0.980-1.800)	0.067	1.241 (0.939-1.639)	0.130
Imaging finding after EVT								
mTICI 2b-3	0.144 (0.036-0.575)	0.006	0.132 (0.033-0.523)	0.004	0.130 (0.033-0.507)	0.003	0.119 (0.031-0.450)	0.002

Hemorrhagic transformation	90.381 (9.213-886.623)	<0.001	89.740 (9.540-844.195)	<0.001	99.500 (10.553-938.187)	<0.001	79.941 (9.017-708.712)	<0.001
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Risk scoring score

Per-1-point increase	1.728 (1.084-2.754)	0.022	1.297 (0.979-1.718)	0.070	1.161 (1.000-1.348)	0.049	1.089 (0.750-1.583)	0.654
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OR, odd ratio; CI, confidence interval; BMI, body mass index; eGFR, estimated using the glomerular filtration rate; National Institutes of Health Stroke Scale, NIHSS; IV, intravenous; IA, intra-arterial; EVT, endovascular thrombectomy; mTICI, modified thrombolysis in cerebral infarction

* administration of tissue plasminogen activator prior to endovascular thrombectomy

Table S4. Clinical and imaging characteristics according to the degree of clinical outcome after EVT (AF-related stroke and non-AF-related stroke)

	AF-related stroke – followed up to 3 months (N=190)			Non-AF-related stroke – followed up to 3 months (N=214)		
	Favorable outcome (mRS 0-2) (N=81)	Unfavorable outcome (mRS 3-6) (N=109)	<i>P</i> -value	Favorable outcome (mRS 0-2) (N=110)	Unfavorable outcome (mRS 3-6) (n=104)	<i>P</i> -value
Age, years, mean (SD)	76.6 ± 10.1	81.9 ± 10.0	<0.001	70.7 ± 14.4	78.3 ± 14.1	<0.001
Female, (%)	47 (58.0%)	52 (47.7%)	0.207	39 (35.5%)	47 (45.2%)	0.189
BMI (kg/m ²)	20.3 ± 4.1	20.2 ± 4.1	0.866	22.1 ± 3.7	20.1 ± 4.4	<0.001
Vascular risk factors						
Hypertension, (%)	60 (74.1%)	91 (83.5%)	0.159	82 (74.6%)	70 (67.3%)	0.310
Diabetes mellitus, (%)	38 (46.9%)	73 (67.0%)	0.009	44 (40.0%)	75 (72.1%)	<0.001
Hypercholesterolemia, (%)	39 (48.2%)	47 (43.1%)	0.588	46 (41.8%)	49 (47.1%)	0.521
Current smoking, (%)	11 (13.6%)	9 (8.3%)	0.346	30 (27.3%)	20 (19.2%)	0.220
eGFR <60 mL/min, (%)	39 (48.20%)	73 (67.0%)	0.014	33 (30.0%)	58 (55.8%)	<0.001
Comorbidities						
Heart failure, (%)	6 (7.4%)	20 (18.4%)	0.050	5 (4.6%)	6 (5.8%)	0.924
Coronary disease, (%)	31 (38.3%)	31 (28.4%)	0.203	36 (32.7%)	22 (21.2%)	0.080
Peripheral artery disease, (%)	2 (2.5%)	4 (3.7%)	0.961	3 (2.7%)	6 (5.8%)	0.443
Previous infarction, (%)	20 (24.7%)	36 (33.0%)	0.278	14 (12.7%)	21 (20.2%)	0.197
Previous hemorrhage	2 (2.5%)	6 (5.5%)	0.506	5 (4.6%)	7 (6.7%)	0.561

Medication before admission						
Prior antiplatelet therapy, (%)	29 (35.8%)	40 (36.7%)	>0.999	28 (25.5%)	34 (32.7%)	0.310
Prior anticoagulation therapy, (%)	27 (33.3%)	26 (23.9%)	0.202	11 (10.0%)	3 (2.9%)	0.068
Prior statin therapy, (%)	31 (38.3%)	33 (30.3%)	0.318	27 (24.6%)	35 (33.7%)	0.188
Initial NIHSS score, median (IQR)	13 (9-16)	18 (14-21)	<0.001	11 (7-15)	18 (12.75-21.25)	<0.001
Treatment						
IA thrombectomy alone, (%)	36 (44.4%)	76 (69.7%)	<0.001	64 (58.2%)	69 (66.4%)	0.276
Combined IV/IA thrombolysis*, (%)	45 (55.6%)	33 (30.3%)	<0.001	86 (47.5%)	52 (34.4%)	0.022
Stent-retriever alone, (%)	70 (86.4%)	72 (66.1%)	0.003	84 (76.4%)	72 (69.2%)	0.308
Aspiration alone, (%)	0 (0.0%)	11 (10.1%)	0.009	5 (4.6%)	7 (6.7%)	0.691
Combined stent-retriever/aspiration**, (%)	11 (13.6%)	26 (23.9%)	0.113	21 (19.1%)	25 (24.0%)	0.475
Number of stent-retrieval passes (SD)	1.8 ± 1.1	2.5 ± 2.4	0.010	1.8 ± 1.4	2.4 ± 2.3	0.013
Onset to puncture, min, mean (SD)	312.2 ± 305.4	318.6 ± 278.7	0.883	365.8 ± 528.6	353.0 ± 323.1	0.830
LNT-to-puncture time (within 6hrs)	63 (77.8%)	78 (71.6%)	0.423	59 (56.7%)	38 (51.4%)	0.577
Image finding after EVT						
mTICI 2b-3	77 (95.1%)	78 (71.6%)	<0.001	104 (94.6%)	73 (70.2%)	<0.001
Hemorrhagic transformation	24 (29.6%)	70 (64.2%)	<0.001	76 (69.1%)	57 (54.8%)	0.044
Pre-admission stroke risk score, median (IQR)						
CHADS ₂ score	4 (3-4)	4 (3-5)	<0.001	2 (1-2)	2 (1-3)	0.001
CHA ₂ DS ₂ VASc score	2 (1-3)	3 (2-3)	<0.001	3 (2-4)	4 (2-4)	<0.001
ATRIA score	8 (6-9)	9 (8-10)	<0.001	6 (1-8)	8 (2-10)	<0.001

Essen score	3 (3-4)	4 (3-4)	0.008	3 (2-4)	3.5 (2-4)	0.050
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EVT, endovascular thrombectomy; AF, atrial fibrillation; mRS, modified Rankin Scale; SD, standard deviation; BMI, body mass index; eGFR, estimated glomerular filtration rate; NIHSS, National Institutes of Health Stroke Scale; IQR, interquartile range; IA, intra-arterial; IV, intravenous; LNT, last normal time

* administration of tissue plasminogen activator prior to endovascular thrombectomy

**cases in which stent retriever and aspiration were performed simultaneously or sequentially

Table S5. Multivariate analysis for stroke risk score correlated with the unfavorable outcome in patients with AF-related stroke (Model 1)

Variables	CHADS ₂		CHA ₂ DS ₂ VASc		ATRIA		Essen	
	OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value
BMI, per-1-kg/m ² increase	1.014 (0.909-1.130)	0.809	1.037 (0.935-1.150)	0.498	1.041 (0.937-1.156)	0.454	1.029 (0.925-1.144)	0.602
eGFR < 60 mL/min	1.442 (0.589-3.529)	0.423	1.675 (0.702-3.995)	0.245	1.522 (0.607-3.816)	0.370	1.721 (0.714-4.149)	0.226
Heart failure	0.912 (0.209-3.981)	0.902	1.247 (0.277-5.607)	0.773	1.768 (0.491-6.357)	0.383	1.992 (0.572-6.941)	0.279
Initial NIHSS score, per 1-score increase	1.153 (1.071-1.242)	<0.001	1.157 (1.074-1.245)	<0.001	1.150 (1.068-1.238)	<0.001	1.164 (1.082-1.252)	<0.001
IV thrombolysis								
IA thrombolysis alone	Reference		Reference		Reference		Reference	
Combined IA/IV thrombolysis*	0.298 (0.135-0.655)	0.003	0.289 (0.132-0.630)	0.002	0.288 (0.132-0.630)	0.002	0.268 (0.124-0.579)	<0.001
IA thrombolysis								
Stent-retriever alone	0.668 (0.226-1.972)	0.465	0.666 (0.227-1.957)	0.459	0.648 (0.222-1.896)	0.429	0.650 (0.222-1.905)	0.432
Aspiration alone	1.214 (0.578-2.516)	0.418	1.317 (0.345-2.148)	0.529	1.258 (0.553-2.121)	0.522	1.325 (0.222-2.525)	0.479
Number of stent-retriever passes, per-1-passes increase	1.290 (0.990-1.681)	0.059	1.273 (0.984-1.648)	0.066	1.301 (0.998-1.695)	0.052	1.239 (0.963-1.595)	0.096

**Imaging finding
after EVT**

mTICI 2b-3	0.123 (0.031-0.491)	0.003	0.115 (0.029-0.450)	0.002	0.115 (0.030-0.438)	0.002	0.112 (0.030-0.414)	0.001
Hemorrhagic transformation	4.170 (1.904-9.131)	<0.001	4.250 (1.961-9.211)	<0.001	4.412 (2.037-9.588)	<0.001	4.311 (2.009-9.250)	0.001

Risk scoring score

Per-1-point increase	1.766 (1.135-2.749)	0.012	1.268 (0.976-1.649)	0.076	1.114 (0.979-1.348)	0.103	1.102 (0.782-1.552)	0.580
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OR, odd ratio; CI, confidence interval; BMI, body mass index; eGFR, estimated using the glomerular filtration rate; National Institutes of Health Stroke Scale, NIHSS; IV, intravenous; IA, intra-arterial; EVT, endovascular thrombectomy; mTICI, modified thrombolysis in cerebral infarction

* administration of tissue plasminogen activator prior to endovascular thrombectomy

Table S6. Comparison of area under curve (AUC) of each stroke risk score by two. (Univariate ROC analysis)

AUC1 vs. AUC2	AUC1	AUC2	<i>p</i> -value
CHADS ₂ score vs. CHA ₂ DS ₂ VASc score	0.654	0.644	0.406
CHA ₂ DS ₂ VASc score vs. ATRIA score	0.644	0.663	0.375
ATRIA score vs. Essen score	0.663	0.596	0.014
CHADS ₂ score vs. ATRIA score	0.654	0.663	0.699
CHADS ₂ score vs. Essen score	0.654	0.596	<0.001
CHA ₂ DS ₂ VASc score vs. Essen score	0.644	0.596	0.011

AUC, area under curve; ROC, receiver operating characteristic

Table S7. Comparison of area under curve (AUC) of each stroke risk score by two in successful recanalization patients. (Univariate ROC analysis).

AUC1 vs. AUC2	AUC1	AUC2	<i>p</i> -value
CHADS ₂ score vs. CHA ₂ DS ₂ VASc score	0.621	0.613	0.567
CHA ₂ DS ₂ VASc score vs. Atria score	0.613	0.642	0.204
ATRIA score vs. Essen score	0.642	0.570	0.014
CHADS ₂ score vs. ATRIA score	0.621	0.642	0.389
CHADS ₂ score vs. Essen score	0.621	0.570	0.004
CHA ₂ DS ₂ VASc score vs. Essen score	0.613	0.570	0.050

AUC, area under curve; ROC, receiver operating characteristic

Table S8. ROC curve analysis (AUC), NRI, and IDI of predictive models for unfavorable outcome in EVT patients

	Model*	Model + CHADS ₂	Model + CHA ₂ DS ₂ VASc	Model + ATRIA	Model + Essen	<i>p</i> **	<i>p</i> [†]	<i>p</i> [‡]	<i>p</i> [§]
ROC curve (AUC)	0.877 (0.844 to 0.910)	0.880 (0.847 to 0.912)	0.877 (0.844 to 0.910)	0.878 (0.845 to 0.911)	0.878 (0.845 to 0.911)	0.430	0.905	0.647	0.662
Category-based NRI (95% CI)		3.6 (-0.7 to 8.0)	1.5 (-1.8 to 4.7)	14.3 (7.5 to 21.1)	3.6 (0 to 7.1)	0.103	0.381	<0.001	0.051
Continuous-based NRI (95% CI)		38.8 (19.8 to 57.8)	19.1 (-0.3 to 38.4)	54.4 (35.6 to 73.1)	28.3 (9.3 to 47.3)	<0.001	0.053	<0.001	0.004
Relative IDI (95% CI)		0.6 (-0.1 to 1.4)	0.1 (-0.3 to 0.5)	3 (1.2 to 4.8)	0.3 (-0.2 to 0.9)	0.111	0.507	0.001	0.194

ROC, receiver-operating characteristics; AUC, area under curve; NRI, net reclassification improvement; IDI, integrated discrimination improvement; EVT, endovascular thrombectomy; CI, confidence interval

*Model included BMI, coronary disease, initial NIHSS score, tPA use, stent-retriever alone, aspiration alone, and number of stent-retriever passes.

**Comparison between Model and Model + CHADS₂

[†] Comparison between Model and Model + CHA₂DS₂VASc

[‡] Comparison between Model and Model + ATRIA

[§] Comparison between Model and Model + Essen