ORIGINAL RESEARCH

Usefulness of the CHADS$_2$ and R$_2$CHADS$_2$ scores for prognostic stratification in patients with coronary artery disease

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Objective: The current risk model for long-term prediction in coronary artery disease (CAD) is complicated, while a simple useful model is still lacking. We aim to investigate if CHADS$_2$ and R$_2$CHADS$_2$ scores could predict long-term outcome for patients with CAD.

Patients and methods: We enrolled 3,700 patients with CAD between November 2010 and September 2014 at the Department of Cardiology from Chinese PLA General Hospital. The CHADS$_2$ and R$_2$CHADS$_2$ scores were calculated. All cases were followed to track the incidence of composite end point consisting of cardiovascular (CV) death, myocardial infarction (MI), stroke, heart failure, and all-cause death.

Results: During a median 2.9-year follow-up, 443 patients experienced at least one element of the composite end point of CV death (n=168 [4.6%]), MI (n=59 [1.6%]), stroke (n=96 [2.6%]), heart failure (n=101 [2.8%]), and all-cause death (n=240 [6.6%]). Multivariate Cox regression analyses showed that the CHADS$_2$ score (hazard ratio [HR]: 2.18, 95% CI: 2.00–2.38, $p<0.0001$) and the R$_2$CHADS$_2$ score (HR: 1.93, 95% CI: 1.83–2.04, $p<0.0001$) were independently associated with composite outcome. Receiver-operating characteristic analysis showed that compared with the CHADS$_2$ score, the R$_2$CHADS$_2$ score had better discrimination for the prediction of long-term combined outcome (0.772 vs 0.791, $p=0.0013$).

Conclusion: CHADS$_2$ and R$_2$CHADS$_2$ scores provide a quick and useful tool in predicting long-term outcome for patients with CAD.

Keywords: CHADS$_2$ score, R$_2$CHADS$_2$ score, coronary artery disease, prognosis, risk factors, renal function

Introduction

Coronary artery disease (CAD) is the leading cause of morbidity and mortality worldwide.[1] Therefore, risk factor assessment and risk stratification of patients with CAD became important aspects of current research. However, the current risk model for long-term survival prediction for these patients was complicated, while a simple useful model was still lacking.[2,3]

The CHADS$_2$ (congestive heart failure, hypertension, age, diabetes, and stroke/transient ischemic attack) score, which assigns one point each for a history of congestive heart failure, hypertension, age ≥75 years, diabetes mellitus (DM), and two points for prior stroke/transient ischemic attack (TIA), was used for embolic risk stratification and guidance in the treatment of anticoagulation for patients with non-valvular atrial fibrillation (AF).[4] Recently, it was demonstrated that the CHADS$_2$ score could predict clinical outcome in patients with acute myocardial infarction (MI),[5] because the score included similar risk factors for poor prognosis.

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A new risk model, the R_2CHADS_2 (renal dysfunction, congestive heart failure, hypertension, age, diabetes, and stroke/TIA) score, was proposed to be a powerful scoring scheme in predicting stroke or systemic embolism in AF patients.[6] Renal dysfunction, the additional component of the R_2CHADS_2 score, was associated with worse clinical outcomes in CAD patients.[7] Compared with the $CHADS_2$ score, the R_2CHADS_2 score was believed to have better prognostic predictive value for stroke of AF patients.[6] However, few studies have investigated the association of R_2CHADS_2 scores with long-term cardiovascular (CV) outcome in patients with CAD. Based on these experiences, we aimed to investigate if $CHADS_2$ and R_2CHADS_2 scores could predict long-term outcome for patients with CAD.

Patients and methods
Study populations
We enrolled 3,700 patients with CAD between November 2010 and September 2014 at the Department of Cardiology from Chinese PLA General Hospital. Patients were included if they met the following criteria: age between 20 and 90 years, angiographic evidence of stenosis of 50% or greater in ≥ 1 coronary vessel and hemodynamically stable. Patients were excluded if they had cardiogenic shock, severe valvular heart disease, myocarditis, severe anemia, active inflammatory disease, or cancer. The Medical Ethics Committee of PLA General Hospital approved the research protocol. All participants provided written informed consent.

Procedures
Demographic characteristics including age, sex, history of DM, hypertension, current cigarette smoking, chronic heart failure, previous ischemic stroke or TIA, medical history of percutaneous coronary intervention and/or coronary artery bypass grafting, and biochemical and echocardiographic examination were obtained from the hospital records. Hypertension was defined as repeated measurements of systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg, or chronic treatment with antihypertensive medications. Diabetes was defined based on hospital records, hemoglobin A1c $\geq 7.0\%$, or the use of antidiabetic medications. Congestive heart failure was defined as left ventricular ejection fraction $<40\%$. Data on prior stroke, TIA, AF, and chronic obstructive pulmonary disease (COPD) were collected from the hospital records. Smoking was defined as smoking 10 cigarettes a day for at least 1 year without quitting. Family history was defined as the presence of heart disease or sudden cardiac death in a male first-degree relative aged <55 years or in a female first-degree relative aged <65 years.

Calculation of $CHADS_2$ and R_2CHADS_2 scores
Thereafter, two experienced cardiologists, without knowledge of the patients' prognosis, calculated the $CHADS_2$ and R_2CHADS_2 scores. The $CHADS_2$ nomenclature represents congestive heart failure (C), HT (H), age (A), DM (D), and stroke (S). The $CHADS_2$ score was calculated by assigning one point each for the presence of congestive heart failure, HT, and DM and by assigning two points for a history of stroke or TIA. The glomerular filtration rate (GFR) was calculated using the Chronic Kidney Disease Epidemiology (CKD-EPI) equation:

$$GFR = 141 \times \min\left(\frac{Scr}{k,1}\right)^a \times \max\left(\frac{Scr}{k,1}\right)^{-1.209} \times 0.993^{Age} \times [1.018 \text{ if female}] \times [1.159 \text{ if black}]$$

The CKD-EPI equation was suggested to offer a more precise assessment of glomerular filtration, as compared to previous equations.[8] The R_2CHADS_2 score was derived by incorporating the components of the $CHADS_2$ score and awarding two points for renal dysfunction, defined as a GFR <60 mL/min/1.73 m². Scr is serum creatinine, k is 0.7 for female and 0.9 for male, a is -0.329 for female and -0.411 for male.

Clinical outcome
Follow-up data were collected by trained research coordinators through telephone interview and hospital records. We selected a composite end point consisting of MI, stroke, heart failure, and all-cause death. MI was defined as a clinical sign of infarction with recurrent chest pain and/or development of new electrocardiogram changes together with a rise of creatine kinase-MB or troponin-T measured following the chest pain. Stroke was defined as a new neurologic deficit, which could not be explained by other causes and with at least one image test (computed tomography or magnetic resonance imaging) compatible with the diagnosis, as well as confirmation from a neurologist. Heart failure was defined as hospitalization for signs and symptoms involving at least two of the following: orthopnea, paroxysmal nocturnal dyspnea, elevated jugular venous pressure, pulmonary rales, third heart sound, and pulmonary edema on radiography. Supportive documentation of reduced cardiac output and elevated pulmonary capillary wedge pressure was assessed when available. All-cause death included CV death and death caused by other reasons. CV death was defined as documentation of diagnoses involving ischemic heart disease, acute coronary syndrome (ACS), heart failure,

cerebrovascular disease, arrhythmia, great vessel or peripheral vascular disease, valvular heart disease, or sudden death because of an unknown but presumed CV cause in high-risk patients. All patients were followed until they either reached the study end point or the end of study follow-up.

Statistical analysis

Descriptive statistics were performed for demographic and biomarker variables. The baseline data were summarized numerically as mean and SD and proportions for categorical variables. Differences between continuous values were assessed using ANOVA test for normally distributed variables. Differences between nominal variables were compared using the χ^2 test. Cox proportional hazards models were used to identify the predictors of composite end point, CV death and all-cause mortality. Associations are reported as hazard ratios (HRs) with 95% CIs. Kaplan–Meier curves were used to illustrate event rates for each risk level defined by score. A log-rank test was used to compare the survival curves among different patient groups. The receiver-operating characteristic curve was also used to demonstrate the sensitivity and specificity of the CHADS$_2$ score and the R$_2$CHADS$_2$ score and their cutoff values for predicting clinical events. The area under

the curve (AUC) comparison of these scoring systems was performed using the Delong method. A p-value of 0.05 was considered significant, and all tests were two tailed. Data were analyzed with SPSS software (version 19.0; IBM Corporation, Armonk, NY, USA) and MedCalc Statistical Software version 12.2 (MedCalc Software bvba, Ostend, Belgium).

Results

Patient's characteristics

After excluding patients with loss of follow-up (n=55) or missing data required for the calculation of CHADS$_2$ and R$_2$CHADS$_2$ scores (n=12), the remaining 3,633 subjects were the subjects of this secondary data analysis. The follow-up rate was 98.5%. The median age was 61.5±11.7 years, and subjects comprised 2,625 (72.3%) men and 1,008 (27.7%) women. The CHADS$_2$ score ranged from 0 to 6, with a mean±SD of 1.3±1.0 and a median of 1 (0–2), while the R$_2$CHADS$_2$ score ranged from 0 to 7, with a mean±SD of 1.6±1.3 and a median of 1 (0–2). Baseline clinical characteristics according to tertiles of R$_2$CHADS$_2$ score are presented in Table 1. Subjects in the highest tertiles were older and more likely to have a history of hypertension, stroke, DM,

Table 1 Baseline clinical characteristics of patients

Characteristics	Overall N=3,633	0–2 n=2,970	3–5 n=610	6–8 n=53	p-value
Age, years	61.5±11.7	59.6±10.7	69.9±12.0	73.2±12.4	<0.001
Male, n (%)	2,625 (72.3)	2,211 (74.4)	378 (62.0)	36 (67.9)	<0.001
Smoking, n (%)	1,091 (30.0)	465 (15.7)	103 (16.9)	9 (17.0)	<0.001
Previous stroke, n (%)	349 (9.6)	245 (8.2)	93 (15.2)	11 (20.8)	<0.001
Previous MI, n (%)	447 (12.3)	329 (11.1)	104 (17.0)	14 (26.4)	<0.001
Hypertension, n (%)	2,373 (65.3)	1,791 (60.3)	533 (87.4)	49 (92.5)	<0.001
Hyperlipidemia, n (%)	1,126 (31.0)	961 (32.4)	158 (25.9)	7 (13.2)	<0.001
Diabetes, n (%)	1,163 (32.0)	794 (26.7)	329 (53.9)	40 (75.5)	<0.001
COPD, n (%)	85 (2.3)	50 (1.7)	30 (4.9)	5 (9.4)	<0.001
AF, n (%)	106 (2.9)	66 (2.2)	35 (5.7)	5 (9.4)	<0.001
Previous PCI, n (%)	903 (24.9)	702 (23.6)	176 (28.9)	25 (47.2)	<0.001
Previous CABG, n (%)	106 (2.9)	73 (2.5)	32 (5.2)	1 (1.9)	<0.001
SBP, mmHg	135.2±22.0	134.3±21.9	139.0±22.3	142.8±23.0	<0.001
DBP, mmHg	75.8±16.6	76.2±17.3	74.0±12.6	72.3±13.8	0.004
BMI, kg/m^2	25.6±3.4	25.7±3.4	25.1±3.6	25.9±3.3	<0.001
ABI	1.1±0.2	1.1±0.2	1.1±0.2	0.9±0.3	0.087
LVEF, %	56.5±8.4	57.5±7.4	52.3±10.5	44.5±9.4	<0.001
TC, mg/dL	4.0±1.1	4.0±1.1	4.0±1.1	3.8±1.3	0.209
TG, mg/dL	1.6±1.0	1.6±0.9	1.6±1.0	1.5±0.8	0.384
HDL-C, mg/dL	1.1±0.3	1.1±0.3	1.1±0.3	1.0±0.3	0.596
LDL-C, mg/dL	2.4±0.9	2.4±0.9	2.4±0.9	2.2±1.0	0.159
Glucose, mg/dL	7.0±4.8	6.8±4.5	7.8±5.9	7.9±3.5	<0.001
Creatinine, μmol/L	86.1±67.9	76.1±34.1	128.7±132.6	156.3±131.1	<0.001
Multivessel disease, n (%)	2,229 (61.4)	1,807 (60.8)	390 (63.9)	32 (60.4)	0.356

(Continued)

Table 1 (*Continued*)

Characteristics	Overall	0–2	3–5	6–8	*p*-value
	N=3,633	n=2,970	n=610	n=53	
CAD type, n (%)					
SA	907 (25.0)	786 (26.5)	113 (18.5)	8 (15.1)	<0.001
UA	2,297 (63.2)	1,857 (62.5)	405 (66.4)	35 (66.0)	
STEMI	125 (3.4)	88 (3.0)	35 (5.7)	2 (3.8)	
NSTEMI	304 (8.4)	239 (8.0)	57 (9.3)	8 (15.1)	
Medication, n (%)					
Aspirin	3,398 (93.5)	2,825 (95.1)	526 (86.2)	47 (88.7)	<0.001
Clopidogrel	2,979 (82.0)	2,441 (82.2)	495 (81.3)	43 (81.1)	0.856
ACEI	1,540 (42.4)	1,199 (40.4)	309 (50.7)	32 (60.4)	<0.001
Statin	3,431 (94.5)	2,830 (95.3)	555 (91.1)	46 (86.8)	<0.001
Beta blocker	2,627 (72.5)	2,134 (72.0)	455 (74.7)	38 (71.7)	0.403

Notes: Data are presented as mean±SD or n (%). R_2CHADS_2, renal dysfunction, congestive heart failure, hypertension, age, diabetes, and stroke/transient ischemic attack.
Abbreviations: ABI, ankle brachial index; ACEI, angiotensin converting enzyme inhibitor; AF, atrial fibrillation; BMI, body mass index; CABG, coronary artery bypass grafting; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; LVEF, left ventricular ejection fraction; MI, myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; PCI, percutaneous coronary intervention; SA, stable angina; SBP, systolic blood pressure; STEMI, ST-segment elevation myocardial infarction; TC, total cholesterol; TG, triglycerides; UA, unstable angina.

and MI. Demographic parameters such as systolic blood pressure, glucose, and creatinine were found to be significantly higher in patients with high R_2CHADS_2 score.

Over a median follow-up of 2.9 years, 443 patients experienced at least one element of the composite end point of CV death (n=168 [4.6%]), MI (n=59 [1.6%]), stroke (n=96 [2.6%]), heart failure (n=101 [2.8%]), and all-cause death (n=240 [6.6%]). Kaplan–Meier plots showed that rates of composite outcome increased with increasing $CHADS_2$ and R_2CHADS_2 scores (Figures 1 and 2). In terms of all-cause death and CV death, similar results were observed.

Predictors of combined outcomes

Using two separate multivariate Cox regression analyses (model 1 was adjusted for sex, smoking, body mass index, hyperlipidemia, GFR, total cholesterol, triglycerides, low-density lipoprotein cholesterol and high-density lipoprotein cholesterol, medication at discharge; model 2 was adjusted for the aforementioned covariates except GFR), the $CHADS_2$ and R_2CHADS_2 scores were strongly associated with the composite end point (Table 2).

Then, we separately evaluated the prognostic value of the two scores in patients with stable CAD and ACS. After adjustment for additional covariates (model 1 for $CHADS_2$
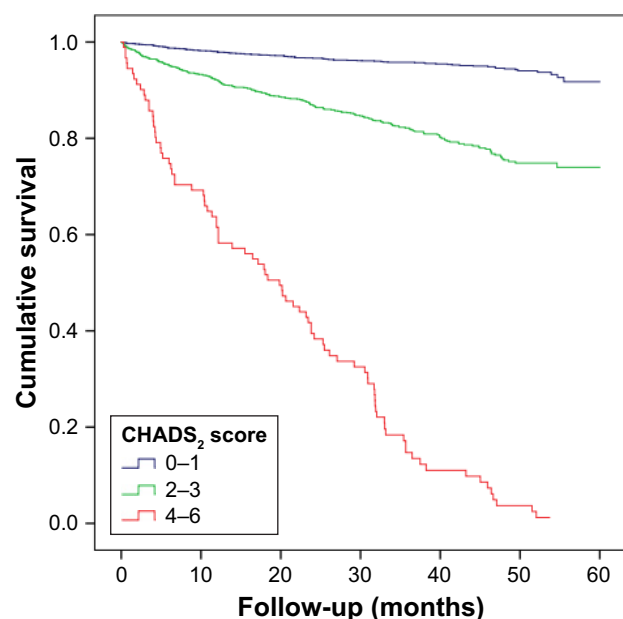

Figure 1 Event-free survival curve for patients according to the $CHADS_2$ score.
Note: $CHADS_2$, congestive heart failure, hypertension, age, diabetes, and stroke/transient ischemic attack.
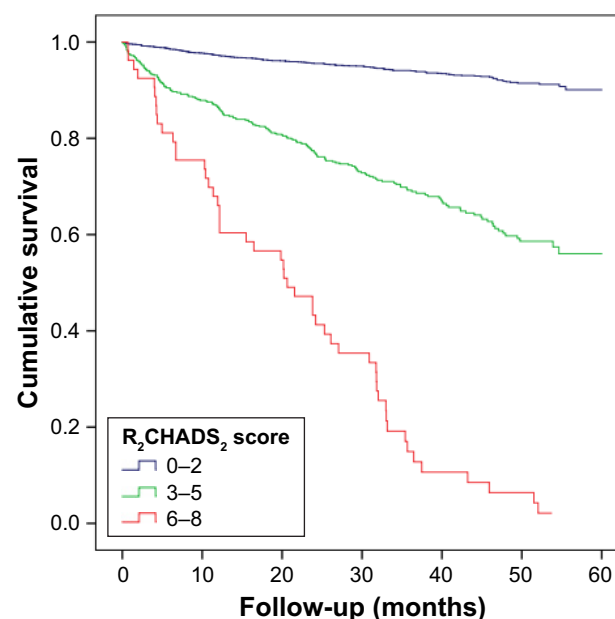

Figure 2 Event-free survival curve for patients according to the R_2CHADS_2 score.
Note: R_2CHADS_2, renal dysfunction, congestive heart failure, hypertension, age, diabetes, and stroke/transient ischemic attack.

Table 2 Predictors for composite outcome in the entire cohort

Variable	Model 1			Model 2			
	HR	95% CI	p-value	HR	95% CI		p-value
BMI	0.9378	0.9116–0.9647	<0.0001	0.9400	0.9131–0.9677		<0.0001
Hyperlipidemia	0.5801	0.4527–0.7433	<0.0001	0.5741	0.4478–0.7361		<0.0001
TG	0.8784	0.7794–0.9900	0.0337	0.8791	0.7796–0.9913		0.0355
HDL-C	0.6389	0.4546–0.8979	0.0099	0.6444	0.4586–0.9053		0.0113
GFR	0.9807	0.9769–0.9846	<0.0001				
Aspirin	0.7233	0.5372–0.9739	0.0328	0.6852	0.5159–0.9101		0.0090
CHADS$_2$	2.1848	2.0075–2.3777	<0.0001				
R$_2$CHADS$_2$				1.9299	1.8288	2.0365	<0.0001

Notes: Cox regression multivariate: model 1 was adjusted for sex, smoking, BMI, hyperlipidemia, GFR, TC, TG, LDL-C, HDL-C, and medication at discharge, while model 2 was adjusted for the aforementioned covariates except GFR. CHADS$_2$, congestive heart failure, hypertension, age, diabetes, and stroke/transient ischemic attack; R$_2$CHADS$_2$, renal dysfunction, congestive heart failure, hypertension, age, diabetes, and stroke/transient ischemic attack.
Abbreviations: BMI, body mass index; GFR, glomerular filtration rate; HDL-C, high-density lipoprotein cholesterol; HR, hazard ratio; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol; TG, triglycerides.

score, model 2 for R$_2$CHADS$_2$ score), the CHADS$_2$ and R$_2$CHADS$_2$ scores were independent predictors of composite outcome, all-cause death and CV death, in both stable CAD and ACS patients (Table 3).

Model performances

Next, we performed receiver-operating characteristic analysis to determine the predictability of the CHADS$_2$ score and the R$_2$CHADS$_2$ score to the composite end point. The AUC was 0.772 (95% CI: 0.758–0.785) for the CHADS$_2$ score and 0.791 (95% CI: 0.777–0.804) for the R$_2$CHADS$_2$ score. With a cutoff value of 2, the CHADS$_2$ score had a sensitivity of 75.8% and a specificity of 66.7% to identify patients with poor clinical outcome. Meanwhile, with a cutoff value of 3, the R$_2$CHADS$_2$ score had a sensitivity of 56.2% and a specificity of 87.0%. Compared with the CHADS$_2$ score, the R$_2$CHADS$_2$ score showed better discrimination for the prediction of long-term combined outcome (0.772 vs 0.791, p=0.0013; Figure 3).

Discussion

In this study, we found that the CHADS$_2$ score was a useful tool in risk stratification and long-term prognosis for patients with coronary heart disease. In particular, the new risk model, R$_2$CHADS$_2$ score, had better predictability than the CHADS$_2$ score of composite outcome for patients with CAD. Both CHADS$_2$ and R$_2$CHADS$_2$ scores could predict long-term clinical outcome for patients with stable CAD and ACS.

The original purpose of the CHADS$_2$ score was for risk stratification in stroke prevention of AF. Among several risk stratification indices, the CHADS$_2$ score is the most commonly used because it is simple to calculate, well validated, and endorsed in practice guidelines. Later, the utility of the CHADS$_2$ score in other CV fields attracted increasing attention.[9] Tasolar et al enrolled 252 non-ST-segment elevation acute coronary syndrome (NSTE-ACS) patients and found that the CHA$_2$DS$_2$-VASc-HS score, which incorporated hyperlipidemia and smoking, was positively correlated with

Table 3 Predictors for clinical outcome in stable CAD and ACS patients

	Stable CAD			ACS		
	HR	95% CI	p-value	HR	95% CI	p-value
Composite outcome						
CHADS$_2$[a]	2.6671	2.1660–3.2843	<0.0001	2.1593	1.9830–2.3513	<0.0001
R$_2$CHADS$_2$[b]	2.0443	1.7664–2.3660	<0.0001	1.9184	1.8178–2.0246	<0.0001
All-cause death						
CHADS$_2$[a]	1.6533	1.1768–2.3228	0.0037	1.5993	1.4150–1.8077	<0.0001
R$_2$CHADS$_2$[b]	1.5429	1.2284–1.9379	<0.0001	1.6741	1.5519–1.8059	<0.0001
Cardiovascular death						
CHADS$_2$[a]	1.5574	1.3347–1.8173	<0.0001	1.5483	1.1757–3.0364	0.0086
R$_2$CHADS$_2$[b]	1.6492	1.4981–1.8156	<0.0001	1.6282	1.4856–1.7846	<0.0001

Notes: Cox regression multivariate: [a]model 1 was adjusted for sex, smoking, BMI, hyperlipidemia, GFR, TC, TG, LDL-C, HDL-C, and medication at discharge, while [b]model 2 was adjusted for the aforementioned covariates except GFR. CHADS$_2$, congestive heart failure, hypertension, age, diabetes, and stroke/transient ischemic attack; R$_2$CHADS$_2$, renal dysfunction, congestive heart failure, hypertension, age, diabetes, and stroke/transient ischemic attack.
Abbreviations: ACS, acute coronary syndrome; BMI, body mass index; CAD, coronary artery disease; GFR, glomerular filtration rate; HDL-C, high-density lipoprotein cholesterol; HR, hazard ratio; LDL-C, low-density lipoprotein cholesterol; TC, total cholesterol; TG, triglycerides.
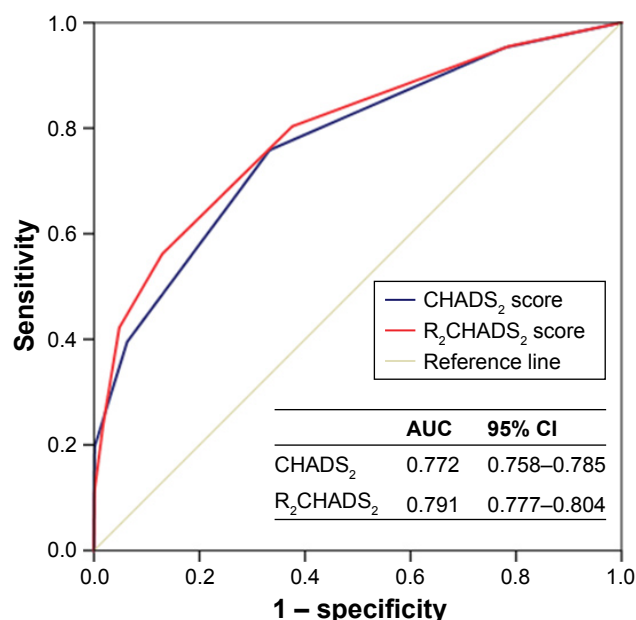
Figure 3 ROC curves for the CHADS$_2$ and R$_2$CHADS$_2$ scores for predicting events.
Note: CHADS$_2$, congestive heart failure, hypertension, age, diabetes, and stroke/transient ischemic attack; R$_2$CHADS$_2$, renal dysfunction, congestive heart failure, hypertension, age, diabetes, and stroke/transient ischemic attack.
Abbreviations: AUC, area under the curve; ROC, receiver operating characteristic.

the severity and complexity of CAD.[10] They also found that CHA$_2$DS$_2$-VASc-HS was comparable with other risk scores for the risk stratification of the in-hospital major adverse cardiac events of NSTE-ACS patients. Welles et al enrolled 916 patients with stable CAD and no AF and reported that the CHADS$_2$ score was strongly predictive of ischemic stroke/TIA (AUC: 0.65).[11] Poci et al enrolled 2,335 participants with ACS and reported that long-term mortality was associated with the CHADS$_2$ score (HR: 1.38, 95% CI: 1.28–1.48).[12]

In line with these findings, this study demonstrated that higher CHADS$_2$ score was associated with higher risk of combined outcome, all-cause death, and CV death in patients with CAD. It is of great importance to assess the risk of CAD patients to provide appropriate medical treatment and reduce CV events and mortality. Thus, several risk prediction scoring systems, including various CAD risk factors, have been developed.[2,13,14] However, simple and reliable tools to identify CAD patients' risks are needed for routine practice. CHADS$_2$ score itself is proved to be a reliable and convenient tool to predict outcome for CAD patients. In fact, it is reasonable to expand the role of CHADS$_2$ score in CAD, since each component of the CHADS$_2$ score is also a risk factor of coronary heart disease and stroke itself also causes disability, further contributing to mortality.

Renal function is a powerful risk factor for mortality in patients with AF. Thus, Piccini et al have made attempts to combine CrCl with the CHADS$_2$ score and created R$_2$CHADS$_2$ score.[6] The CrCl was calculated with the Cockcroft–Gault formula. In this study, when calculating GFR, we used the CKD-EPI equation instead of the Cockcroft–Gault formula; it was because a previous study showed that GFR-based scheme, R$_2$(GFR)CHADS$_2$, provided a significant improvement of predictive ability for mortality risk in older patients with AF.[15] In a recent study, Huang et al enrolled 3,295 subjects with CAD and found that R$_2$CHADS$_2$ had comparable predictive ability of mortality to the Global Registry of Acute Coronary Events score.[16] Compared with the CHADS$_2$ score (c-statistic =0.61), the R$_2$CHADS$_2$ (c-statistic =0.66, $p<0.05$) score provides better discrimination for mortality. The results of this study suggested that the R$_2$CHADS$_2$ score could be used to predict composite events for patients with CAD, and the AUC of the R$_2$CHADS$_2$ was statistically larger than of the CHADS$_2$ score. The clinical utility of the R$_2$CHADS$_2$ score should be emphasized, for those with a R$_2$CHADS$_2$ score of ≥3 had a rate of adverse events as high as 37.6%. These results indicated that reduced renal function played a critical role in the prognosis of CV outcomes in patients with CAD. Several potential mechanisms may explain these findings. Patients with reduced renal function often have consequences such as anemia, volume overload, and oxidative stress, which contribute to the poor outcomes.[17] In addition, it has been reported that impaired renal function causes decreased number of smooth muscle cells within the plaque, which may accelerate the formation of vulnerable plaque and increase the possibility of plaque disruption.[18,19]

To our knowledge, although the CHADS$_2$ score has already been tested in a previous study, the prognostic role of the R$_2$CHADS$_2$ score in long-term composite outcome in patients with CAD has not been addressed before. This study suggests that the R$_2$CHADS$_2$ score may predict risk with reasonable efficacy for patients with stable CAD and ACS.

Limitations

This study has several limitations. First, detailed information about the complexity of coronary artery lesions, such as the SYNTAX score, total or non-total arterial revascularization, was not evaluated. These factors are associated with long-term CV outcomes. In addition, the results need to be further validated in multicenter trials.

Conclusion

The CHADS$_2$ and R$_2$CHADS$_2$ scores can be used to estimate the risk of clinical adverse events in patients with CAD. These

scoring systems could lead to optimization of therapy, which might reduce the risks of subsequent adverse events.

Acknowledgment

Disclosure

The authors report no conflicts of interest in this work.

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