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Original Article

$CHADS_2$ and modified CHA_2DS_2-VASc scores for the prediction of congestive heart failure in patients with nonvalvular atrial fibrillation

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ABSTRACT

Background & purpose: We have conducted a retrospective observational study to analyze the correlation between the $CHADS_2$ score, the modified CHA_2DS_2-VASc ($mCHA_2DS_2$-VASc) score, and the incidence of all-cause death and congestive heart failure (CHF).
Methods: The study cohort consisted of 292 consecutive patients with nonvalvular atrial fibrillation (NVAF) admitted to our hospital from 2012 to 2014. Electronic medical records were used to confirm medical history including prior heart failure, hypertension, diabetes, stroke, and coronary disease. A follow-up survey for all-cause deaths and incidence of CHF was carried out from the baseline data to May 2015. We analyzed the correlation between each score and the endpoints using the Kaplan-Meier method and the Cox proportional hazards model.
Result: During the follow up period (mean = 1.6 years), 69 all-cause deaths and 58 CHF events occurred in the cohort. There was no significant association between these scores and all-cause death in our CHF cohort. The incidence of CHF significantly increased along with increased $CHADS_2$ ($p = 0.018$) or $mCHA_2DS_2$-VASc scores ($p = 0.044$). The hazard ratio (HR) for CHF after adjustment for drug treatment was obtained from a Cox proportional hazards model. The HRs for the $CHADS_2$ and $mCHA_2DS_2$-VASc scores were 1.38 (95% CI; 1.13–1.68) and 1.35 (95% CI; 1.24–1.59), respectively.
Conclusion: Calculation of the $CHADS_2$ and $mCHA_2DS_2$-VASc scores in order to evaluate the risk of systemic thromboembolism was useful to predict the onset of CHF, but not all-cause death, in patients with NVAF.

1. Introduction

Atrial fibrillation (AF) increases the risk of ischemic stroke, dementia, congestive heart failure (CHF), and all-cause death. Therefore, AF frequently decreases quality of life in a large number of elderly patients [1]. The $CHADS_2$ [2] and modified CHA_2DS_2-VASc ($mCHA_2DS_2$-VASc) scores [3] for patients with nonvalvular atrial fibrillation (NVAF) have been proposed for the evaluation of the risk of systemic thrombosis including ischemic stroke.

AF rates have increased in tandem with the aging of the Japanese population, as in Western countries [4]. Indeed, the Japanese elderly population is growing particularly rapidly within the study area. Hence, evaluation of the risk and availability of the appropriate treatment for patients with AF in rural hospitals is particularly important.

Both the $CHADS_2$ and $mCHA_2DS_2$-VASc scores are predictors of various categories of cardiovascular (CV) hospitalization among patients with NVAF or atrial flutter [5]. Moreover, it has been reported that the risk of death after stroke increases linearly with the $CHADS_2$ score [6]. Perni et al. have recently demonstrated that the CHA_2DS_2-VASc score is an independent predictor of death and CHF events in patients undergoing cardiac resynchronization therapy (CRT) [7]. However, in rural areas of Japan, few studies on

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the correlation between established scoring systems and outcomes in patients with NVAF have been conducted.

Therefore, we conducted a retrospective observational study at a local base hospital in a coastal area of the Iwate prefecture in order to analyze the correlation between the $CHADS_2$ score, the $mCHA_2DS_2$-VASc score, and the incidence of all-cause death and CHF in hospitalized patients with NVAF.

2. Materials and methods

A total of 1428 patients were hospitalized in our division of the Iwate Prefectural Ofunato Hospital between January 2012 and December 2014. Among this group, permanent (chronic) or paroxysmal AF was confirmed in 318 patients (22% of all inpatients) based on 12-lead and 24-hour monitoring electrocardiography. We excluded valvular AF (VAF: mitral valve stenosis=11, post-heart valve prosthesis=15), and analyzed the remaining patients with nonvalvular atrial fibrillation (NVAF, $n=292$). The main reasons for admission were cardiovascular events such as CHF ($n=120$), arrhythmia ($n=40$), myocardial ischemia ($n=43$), and detailed cardiac examination ($n=30$). The remaining patients were hospitalized with pneumonia ($n=27$), dehydration ($n=5$), or other conditions ($n=23$). The study protocol was approved by the Ethics Committee of Iwate Prefectural Ofunato Hospital and conducted in accordance with the guidelines of the Declaration of Helsinki.

Electronic medical records were used to evaluate background factors and medical history in order to establish baseline data as follows: age, gender, dates of admission, anticoagulant drug use (warfarin or NOAC; non-vitamin K antagonist oral anticoagulants), drugs for CHF, blood pressure, left ventricular ejection fraction (LVEF) by echocardiography, prior history of heart failure, hypertension, diabetes, stroke, and coronary artery disease. Attending physicians administered anticoagulant therapy at their own discretion. The target PT-INR value for patients with AF who are prescribed warfarin is 2.0–3.0 (age $\geq$70 years old: 1.6–2.6).

The $CHADS_2$ and $mCHA_2DS_2$-VASc scores were calculated based on data gathered at the index admission. In accordance with Gage's report [2], the $CHADS_2$ score was calculated by assigning 1 point each for a prior history of CHF diagnosed by cardiologist or left ventricular dysfunction (LVEF $<45\%$), hypertension (systolic blood pressure $\geq$140 mm Hg and/or medication), age 75 years or older, and diabetes mellitus (HbA1c $\geq$6.5% and/or medication); 2 points were assigned for a history of stroke or transient ischemic attack (max 6 points). In accordance with Okumura's report [3], the $mCHA_2DS_2$-VASc score was determined by assigning 1 point each for a prior history of CHF diagnosed by cardiologist or left ventricular dysfunction (LVEF $<45\%$), hypertension (systolic blood pressure $\geq$140 mm Hg), age 65 years or older, age 75 years or older, and diabetes mellitus (HbA1c $\geq$6.5% and/or medication), coronary artery disease, and female gender; 2 points were assigned for a history of stroke or transient ischemic attack (max 9 points). The definition of "C" in $CHADS_2$ and $mCHA_2DS_2$-VASc scores was a prior history of CHF as diagnosed during routine clinical practice, including history taking or echocardiography (left ventricular dysfunction defined as LVEF $<45\%$). Patients were divided into three groups as follows: (1) the low score group ($CHADS_2$ / $mCHA_2DS_2$-VASc score=0 points), (2) the intermediate score group ($CHADS_2$ / $mCHA_2DS_2$-VASc score=1 points), and (3) the high score group ($CHADS_2$ / $mCHA_2DS_2$-VASc score $\geq$2 points).

The follow-up survey for all-cause death and the incidence of complications was carried out from the baseline study (before discharge from the index admission) until May 2015. Authors investigated the date of all-cause death or rehospitalization with hemorrhagic disease, ischemic stroke, or CHF in patients who attended Ofunato Hospital after discharge. Confirmation of thromboembolism was based on clinical symptoms and CT or magnetic resonance imaging (MRI) findings. The definition of the incidence of CHF in the present study was hospitalization due to "new onset or recurrent onset of CHF" as defined by the Framingham criteria [8]. CHF events were subdivided into two parts: heart failure with reduced ejection fraction (HFrEF, LVEF $<45\%$) and heart failure with preserved ejection fraction (HFpEF, LVEF $\geq45\%$). Twenty-seven NVAF inpatients were transferred to a different hospital to receive treatment. Prognosis questionnaires regarding these patients were sent to the destination medical institution to evaluate their outcomes (response rate=93%). The follow-up rate of this study was 99%.

2.1. Statistical analysis

We conducted a retrospective observational study to analyze the correlation between the $CHADS_2$ score, the CHA_2DS_2-VASc score, and the incidence of endpoints. Numerical values are expressed as means $\pm$ standard deviation. The Mann-Whitney U test for statistical analysis and the χ^2 test for comparing ratios were used to compare background factors among the patient groups. The Kaplan-Meier method and univariate and multivariate Cox proportional hazards models were used to analyze outcomes among groups. The performance of each score in predicting the risk of CHF was analyzed with the C statistic and compared by differences in the area under the curve (AUC) according to the receiver-operating characteristic (ROC) curve.

The above analysis was performed using the software package SPSS 20.0 for Windows, with the level of significance set at $p<0.05$.

3. Results

Table 1 shows the clinical characteristics of the study subjects. The mean age at admission was 77.6 years. The proportion of males was significantly higher than that of females. Eighty-seven patients had not received anticoagulant drugs (30% of patients with NVAF), while 171 had received warfarin (59% of patients with NVAF) and 34 had received NOAC (11% of patients with NVAF) at discharge.

Mean $CHADS_2$ and $mCHA_2DS_2$-VASc scores among the 292 patients with NVAF were 2.7 and 3.6 points, respectively. Fig. 1 shows the frequency distribution of each score in the patients with NVAF. None of the patients exhibited a $mCHA_2DS_2$-VASc score of 9 points.

Table 1
Characteristics of patients with NVAF.

Total (n)	292
Age (years)	77.6 ± 10.8
Gender (male / female)	166/126
Without anticoagulant drug	87 (30%)
Warfarin	171 (59%)
NOAC	34 (11%)
Loop diuretic	177 (61%)
ACE inhibitors	64 (22%)
ARB	92 (32%)
Beta-blockers	149 (51%)
Potassium-sparing diuretic	57 (20%)
Digitalis	56 (19%)
PD3 inhibitors	4 (1.4%)
Average of LVEF (%)	52.5 ± 15.6
Average $CHADS_2$ score	2.7 ± 1.3
Average mCHA2DS2-VASc score	3.6 ± 1.6