

Prevalence of Atrial Fibrillation in Patients with High CHADS₂- and CHA₂DS₂VASc-Scores: Anticoagulate or Monitor High-Risk Patients?

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Background: In patients with known atrial fibrillation (AF) different scores are utilized to estimate the risk of thromboembolic events and guide oral anticoagulation. Diagnosis of AF strongly depends on the duration of electrocardiogram monitoring. The aim of this study was to use established scores to predict the prevalence of AF.

Methods: The CHADS₂- (Congestive Heart failure, hypertension, Age >75 years, Diabetes, Stroke [doubled]) and CHA₂DS₂VASc-score (Congestive Heart failure, hypertension, Age ≥75 years [doubled], Diabetes, Stroke [doubled], Vascular disease, Age 65–74 years, Sex category [female sex]) was calculated in 150,408 consecutive patients, referred to the University Hospital of Rostock between 2007 and 2012. All factors constituting these scores and a history of AF were prospectively documented with the ICD-10 admission codes.

Results: Mean age of our study population was 67.6 ± 13.6 years with a mean CHADS₂-score of 1.65 ± 0.92 and CHA₂DS₂VASc-score of 3.04 ± 1.42. AF was prevalent in 15.9% of the participants. The prevalence of AF increased significantly with every CHADS₂- and CHA₂DS₂VASc-score point up to 54.2% in CHADS₂-score of 6 and 71.4% in CHA₂DS₂VASc-score of 9 (*P* < 0.001).

Conclusion: The prevalence of AF increases with increasing CHADS₂- and CHA₂DS₂VASc-score. In intermediate scores intensified monitoring may be recommended. In high scores, thromboembolic complications occurred irrespective of the presence of AF and anticoagulant therapy may be initiated irrespective of documented AF. (*PACE* 2014; 37:1651–1657)

atrial fibrillation, prevalence, risk factors, stroke prevention

Introduction

Atrial fibrillation (AF) is a frequent arrhythmia with an estimated prevalence of 1.5–2% in developed countries.^{1,2} The occurrence is suspected to rise due to an ageing population and the progressive nature of the arrhythmia.^{2–6} Besides, AF is associated with increased morbidity, mortality, and risk of thromboembolism, which can be significantly reduced with oral anticoagulation.^{2,7–11} The CHADS₂- (Congestive Heart failure, hypertension, Age >75 years, Diabetes, Stroke [doubled]) and CHA₂DS₂VASc- (Congestive Heart failure, hypertension, Age ≥ 75 years [doubled], Diabetes, Stroke [doubled], Vascular disease, Age 65–74 years, Sex category [female sex]) score have been established to guide antithrombotic therapy in individuals with known AF.^{8,12,13} However, AF is often not diagnosed until patients present with thromboembolic complications.^{1,2,11,14} In up to 25% of patients, AF is suspected to be the cause of a cryptogenic

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stroke.^{11,14} Therefore, early identification of individuals with AF seems to be warranted in order to prevent associated complications.^{1,8}

Many efforts have been undertaken to create models for the identification of patients at risk of AF before complications become apparent. So far, risk stratification has been limited to small cohorts or restricted age groups. Finally, risk stratification was not easily adopted in daily practice.^{3,15} The CHADS₂- and CHA₂DS₂VASc-score are well-established tools to estimate the risk of thromboembolic events in individuals with known AF.^{1,8,12,13} Some features of these scores are not only used to predict the risk of thromboembolic complications, but also to predict the occurrence of AF.^{3,8,15}

In this study, we hypothesized that the CHADS₂- and CHA₂DS₂VASc-score may predict the prevalence of AF and may be used to guide cardiac monitoring.

Methods

A total of 150,408 patients who were referred to different medical departments in the University Hospital of Rostock between January 1, 2007 and December 31, 2012 were included in this study. The CHADS₂- and CHA₂DS₂VASc-scores were prospectively and electronically documented using the International Statistical Classification of Diseases, 10th Revision (ICD-10) codes: Hypertension (ICD-10 codes I10–I15), previous transient ischemic attack (TIA), stroke or arterial thromboembolism (ICD-10 codes G45.9, I63.0–I63.9, and I74–I74.9), congestive heart failure (ICD-10 codes I50.00–I50.01, I50.9, I50.11–I50.14, and I50.19), and diabetes (ICD-10 codes E10.0–E14.91). In addition, vascular diseases such as myocardial infarction (ICD-10 codes I21.0–I21.9, I22.0–I22.9, and I25.20–I25.29), coronary artery disease (ICD-10 codes I25.0–I25.19), peripheral arterial occlusive disease (ICD-10 codes I70.2–I70.25), or atherosclerosis of the aorta (ICD-10 code I70.0) were documented. Age at the time of admission and gender were also recorded in all patients. Based on this data, the CHADS₂- and CHA₂DS₂VASc-score was calculated for each patient. Finally, patients were identified with an admission code of AF (ICD-10 codes I48.0–I48.2, and I48.9) based on anamnestic data, electrocardiogram (ECG)-recording, Holter monitoring, and data from cardiac devices. Precisely, in patients with anamnestic AF there had to be at least one ECG with documented AF before hospitalization, based on a physician recall. In patients with first detected AF during the hospital stay, we used ECG recording, Holter monitoring, and also data from loop recorders and cardiac devices for the diagnosis of AF. An episode of AF was defined as an event lasting greater than 30 seconds in

duration. Patients with paroxysmal as well as persistent AF were included in our study.

Statistical Analysis

All data were stored and analyzed using the SPSS statistical package 21.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were computed for continuous and categorical variables. The statistics computed included mean and standard deviation (SD) of continuous variables and are presented as mean \pm SD, frequencies, and relative frequencies of categorical factors.

Comparisons between groups for categorical variables were done using the χ^2 or Fisher's exact test and for continuous variables using a *t*-test for independent samples. The logistic regression model was used to evaluate the influence of several factors constituting the scores on risk for AF. Evaluation was done by computation of odds ratios (OR), 95% confidence intervals (95% CI), and examination the significance of the Wald statistic. All P values resulted from two-sided statistical tests and values of $P < 0.05$ were considered to be statistically significant.

Results

A total of 150,408 patients were included in the study; mean age was 67.6 ± 13.6 years (Table I). A total of 46,602 patients (31%) were between 65 years and 74 years and 51,720 older than 74 years of age (34.4%, Table I). The majority (56.9%) were male. AF was known in 23,905 patients (15.9%) with a mean age of 72.8 ± 10.5 years (Table I). Of 150,408 patients, 80.2% suffered from hypertension. Diabetes mellitus was present in 35.3% and vascular diseases in 30.4% of patients. Congestive heart failure was documented in 10.2%, a history of TIA or stroke in 4.0% of patients.

CHADS₂-Score

The mean CHADS₂-score was 1.65 ± 0.92 . The prevalence of AF was 10.1%, 15.5%, 25.8%, 37.4%, 45.9%, and 54.2% in patients with a CHADS₂-score between 1 and 6, respectively (Table II, Fig. 1). This prevalence of AF increased continuously and significantly by 5.4–11.5% with every score point ($P < 0.001$).

The rising prevalence of AF with an increasing CHADS₂-score was present in the whole cohort irrespective of the medical department patients were admitted to and the underlying disease that caused the hospitalization (Table II). The prevalence was highest in patients who were admitted to cardiology and cardiac surgery because AF was the reason for admission in many patients. Still, the prevalence increased with an increasing score. Overall, the prevalence of AF was significantly increased in patients older than 74 years of age (OR = 2.09, 95% CI: 2.04–2.15), with congestive heart

Table I.
Baseline Characteristics

Variable	n	%	Without AF		With AF		P Value
			n	%	n	%	
Patients	150,408	100	126,503	84.1	23,905	15.9	
Age (mean ± SD) years	67.6 ± 13.6		66.6 ± 13.9		72.8 ± 10.5		<0.001
Age <65 years	52,086	34.6	47,577	37.6	4,544	19.0	
Age 65–74 years	46,602	31.0	38,994	30.8	7,608	31.8	
Age >74 years	51,720	34.4	39,932	31.6	11,753	49.2	
Age >75 years	46,286	30.8	35,567	28.1	10,665	44.6	
Female	64,835	43.1	54,748	43.3	10,087	42.2	0.002
Congestive heart failure	15,326	10.2	9,932	7.9	5,394	22.6	<0.001
Hypertension	120,631	80.2	102,830	81.3	17,801	74.5	<0.001
Diabetes mellitus	53,115	35.3	44,236	35.0	8,879	37.1	<0.001
History of stroke	5,984	4.0	4,302	3.4	1,682	7.0	<0.001
Vascular disease	45,755	30.4	36,603	28.9	9,152	38.3	<0.001

AF = atrial fibrillation; SD = standard deviation.

Table II.
Prevalence of Atrial Fibrillation with Increasing CHADS₂-Score and Main Reason for Hospitalization

CHADS ₂ -Score	Prevalence of AF (%)						
	All	Cardiology/ Cardiac Surgery	Dermatology	Neurology	Surgery	Otorhinolaryngology	Ophthalmology
1	10.1	21.2	10.7	6.0	6.2	3.7	3.0
2	15.5	26.2	17.1	15.0	10.8	7.9	4.3
3	25.8	36.7	29.4	22.7	19.0	13.8	5.8
4	37.4	45.2	40.6	32.2	36.7	22.9	75.0
5	45.9	60.0	35.7	44.9	68.0	28.6	25.0
6	54.2	38.5	20.0	57.1	88.9	100.0	0
Mean ± SD [†]	1.65 ± 0.92						

CHADS₂-Score = Congestive Heart failure, hypertension, Age >75 years, Diabetes, Stroke (doubled); SD = standard deviation.

failure (OR = 3.42, 95% CI: 3.30–3.55), diabetes mellitus (OR = 1.10, 95% CI: 1.07–1.13), and a history of stroke (OR = 2.12, 95% CI: 2.00–2.24; Table III). Surprisingly, the prevalence of AF was lower in patients with hypertension (OR = 0.67, 95% CI: 0.65–0.69; Table III).

The prevalence of stroke increased from 0% to 93.8% between a CHADS₂-score of 1 and 6 (Table IV). Up to a score of 3, the prevalence of stroke was higher in patients with known AF. Beyond a score of 3, patients showed a high prevalence of stroke irrespective of AF (Table IV).

CHA₂DS₂VASc-Score

The mean CHA₂DS₂VASc-score was 3.04 ± 1.42 in the whole cohort. The prevalence of AF increased progressively and significantly from 9.9% in patients with a CHA₂DS₂VASc-score of 1–71.4% in patients with a CHA₂DS₂VASc-

score of 9 (P < 0.001, Table V, Fig. 1). The increasing prevalence of AF in patients with increasing CHA₂DS₂VASc-scores was apparent in all medical departments and irrespective of the underlying disease that lead to the hospitalization (Table V, Fig. 2).

Comparable to the CHADS₂-score the prevalence of AF was also higher in cardiology and cardiac surgery patients and increased with an increasing score. The logistic regression analyses of factors constituting the CHA₂DS₂VASc-score revealed the same results for age, congestive heart failure, diabetes mellitus, history of stroke, and hypertension as the CHADS₂-score (Table III). In addition, female patients had a slightly decreased prevalence of AF compared with males (OR = 0.96, 95% CI: 0.93–0.98). Patients with vascular disease had an increased relative risk of AF (OR = 1.52, 95% CI: 1.48–1.57) (Table III).

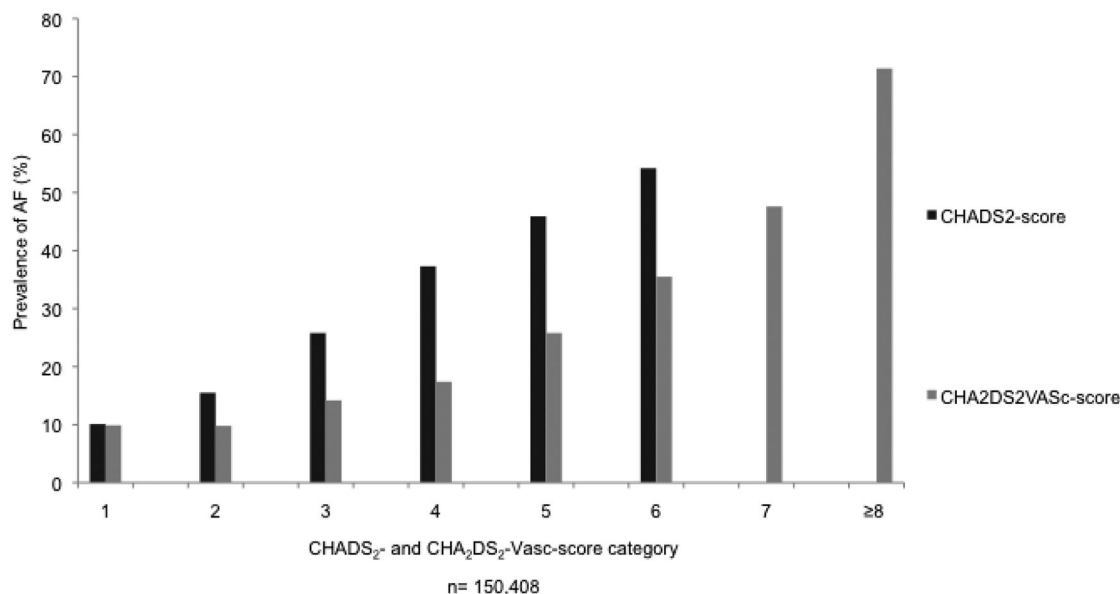


Figure 1. Prevalence of atrial fibrillation (AF) in different CHADS₂- (Congestive Heart failure, hypertension, Age > 75 years, Diabetes, Stroke [doubled]) and CHA₂DS₂VASc-score (Congestive Heart failure, hypertension, Age ≥ 75 years [doubled], Diabetes, Stroke [doubled], Vascular disease, Age 65–74 years, Sex category [female sex]) categories.

Table III.

Prevalence of Atrial Fibrillation and Factors Constituting the CHADS₂-Score and the CHA₂DS₂VASc-Score

Variable	Odds Ratio	95% CI	P Value
>74 years	2.09	2.04–2.15	<0.001
Congestive heart failure	3.42	3.30–3.55	<0.001
Hypertension	0.67	0.65–0.69	<0.001
Diabetes mellitus	1.10	1.07–1.13	<0.001
History of stroke	2.12	2.00–2.24	<0.001
Female sex	0.96	0.93–0.98	<0.001
Vascular disease	1.52	1.48–1.57	<0.001

CHA₂DS₂VASc-Score = Congestive Heart failure, hypertension, Age 75 years (doubled), Diabetes, Stroke (doubled), Vascular disease, Age 65–74 years, Sex category (female sex); CI = confidence intervals. Other abbreviations as in previous tables.

The prevalence of stroke rose from zero to a maximum of 96.4% between CHA₂DS₂VASc-score 1 and 9 (Table VI). Up to a score of 6, the prevalence of stroke was higher in patients with AF. Beyond a score of 6, the prevalence of stroke was high irrespective of AF.

Discussion

Prevalence of AF

The prevalence of AF was 15.9% in our study population (mean age of 67.6 ± 13.6 years). In the general population aged over 65 years, the

Table IV.

Prevalence of Stroke and CHADS₂-Score

CHADS ₂ -Score	Prevalence of Stroke (%)		
	All	All	With AF
0	7,782	0	0
1	68,288	0	0
2	50,534	1.5	9.7
3	17,918	11.0	20.1
4	4,856	47.0	32.8
5	934	96.5	46.2
6	96	93.8	55.6

Abbreviations as in previous tables.

prevalence of AF is estimated to be between 6% and 8%.^{5,16,17} One reason for the higher prevalence in our study may be that many patients have been presented to our hospital for AF as reflected in the high prevalence of AF in patients who were admitted to “the cardiology-” or cardiac surgery department. Besides, patients revealed considerable comorbidities as depicted by a mean CHADS₂-score of 1.65 ± 0.92 and the mean CHA₂DS₂VASc-score of 3.04 ± 1.42. However, the increasing prevalence of AF with higher scores was apparent in all departments and independent of the reason for hospitalization. In addition, a

Table V.
Prevalence of Atrial Fibrillation with Increasing CHA₂DS₂VASc-Score and Main Reason for Hospitalization

CHA ₂ DS ₂ VASc-Score	Prevalence of AF (%)						
	All	Cardiology/ Cardiac Surgery	Dermatology	Neurology	Surgery	Oto-rhinolaryngology	Ophthalmology
1	9.9	31.9	9.1	4.7	5.0	2.7	3.1
2	9.9	20.6	10.5	6.4	6.7	4.5	3.4
3	14.2	23.0	16.5	12.0	10.1	8.1	3.9
4	17.4	25.3	20.5	17.4	11.9	9.3	4.7
5	25.8	30.6	29.5	26.0	19.0	11.3	6.9
6	35.5	35.8	35.6	37.3	30.8	20.8	20.0
7	47.6	47.9	46.7	48.0	46.9	40.0	50.0
8	50.2	41.2	23.5	50.3	80.0	100	100
9	71.4	50.0	100	77.8	100	0	0
Mean ± SD	3.04 ± 142						

Abbreviations as in previous tables.

prevalence of AF with up to 30–34% has been described in patients with intensified monitoring with implanted devices during a follow up of 1.1–2.5 years.^{18,19} In line with our data Engdahl et al. reported a prevalence of 14% in a population of 75 years and 76 years of age using a special screening program.²⁰

The Prevalence of AF and Thromboembolic Complications

In patients with known AF risk factors for stroke have been investigated in detail and “resulted in the widely accepted” CHADS₂- and CHA₂DS₂VASc-score to identify patients who may benefit from oral anticoagulation.⁸ But little is known about the occurrence of AF in patients with stroke risk factors.^{19–22}

We could demonstrate that the prevalence of AF rises significantly with every CHADS₂- and CHA₂DS₂VASc-score point, independent of the attending medical department and the underlying disease that lead to hospitalization. Patients with a CHADS₂-score of 5 and 6 had AF in 45.9% and 54.2%, respectively. Patients with a CHA₂DS₂VASc-score between 6 and 9 had AF in 35.3% to 71.4%. In contrast to our study, Ziegler et al. detected AF in 30% of patients during a mean follow-up of 1.1 year with implantable loop recorders.¹⁸ The occurrence of AF was not related to underlying CHADS₂-score and the diagnosis was based on any episode of AF irrespective of symptoms. However, AF lasting longer than 6 hours/day was associated with a higher CHADS₂-score.¹⁸ This may indicate that the scores predict persistent and longer lasting episode of AF rather

than short episodes of paroxysmal AF. In addition, Zuo et al. demonstrated that in patients without documented AF but arrhythmic symptoms, a high CHADS₂- and CHA₂DS₂VASc-score was associated with a high risk of a new onset of AF.²³

In patients with CHADS₂-score of more than 4 and a CHA₂DS₂VASc-score of more than 7 the prevalence of stroke was high and independent of AF.

In contrast, the prevalence of thromboembolic complications was two to five times higher with CHADS₂-score below 4 and CHA₂DS₂VASc-score below 7, if AF was present.

We, therefore, conclude that using the CHADS₂- and CHA₂DS₂VASc-score it may be possible to detect patients with a high risk of AF and thromboembolic complications if AF is present. With very high scores the risk of thromboembolic complications may no longer be dependent on AF. While intensified monitoring may be warranted in the former patients, anticoagulation may be warranted in the latter. This hypothesis should be tested in a prospective trial, which is underway in collaboration with Biotronik (Cleopatra Trial; Biotronik GmbH, Berlin, Germany). In this randomized trial, patients postmyocardial infarction with a CHADS₂-score of more than 2 undergo intensified monitoring with an implantable loop recorder.

Limitations

The study was carried out in a single community and there may be a selection bias, because all patients were referred to our hospital for various clinical reasons. However, the relationship

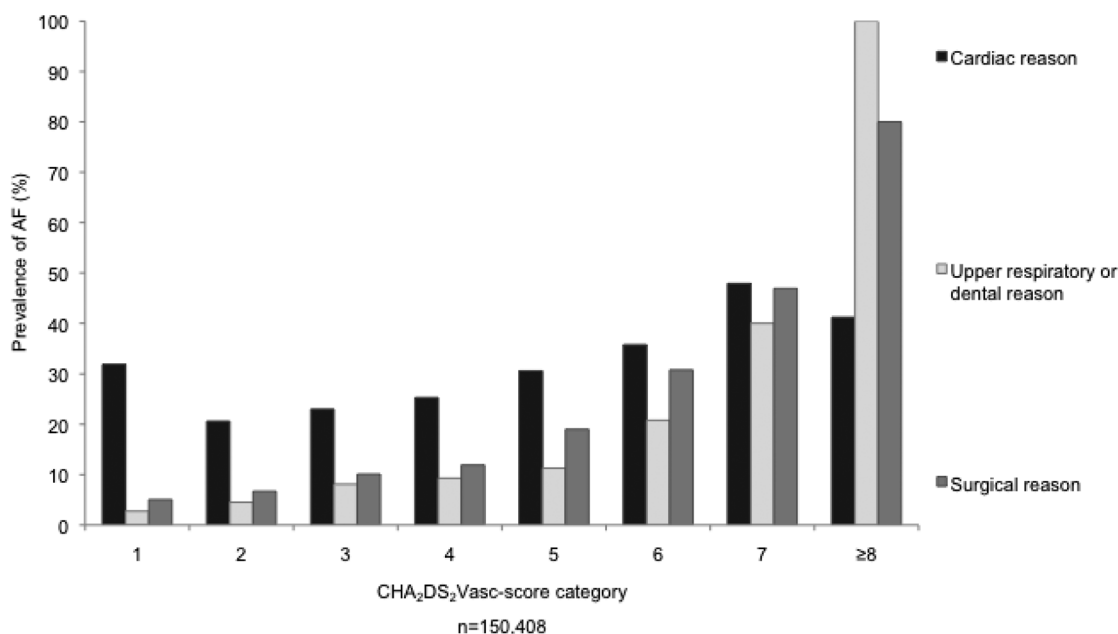


Figure 2. Prevalence of AF in different CHA₂DS₂VASc-score categories and diverse reasons for hospitalization. Abbreviations as in Figure 1.

Table VI.

Prevalence of Stroke and CHA₂DS₂VASc-Score

CHA ₂ DS ₂ VASc-Score	Prevalence of Stroke		
	All	All (%)	With AF (%)
0	1,425	0	0
1	20,047	0	0
2	36,246	0.8	5.2
3	38,171	2.0	8.7
4	32,064	3.4	17.1
5	15,308	9.1	25.9
6	5,475	25.6	37.3
7	1,394	57.2	49.1
8	249	96.8	51.0
9	28	96.4	70.4

Abbreviations as in previous tables.

between the prevalence of AF and the CHADS₂- or CHA₂DS₂VASc-score was present in all departments irrespective of the reason for referral. In addition, these data were primarily collected to generate reimbursement from health insurances and not primarily for medical reasons. Clinical details such as the severity of AF were not documented. Furthermore, information concerning

medication was not available. Nevertheless, in Germany under- and overcoding of diseases is under penalty, so documented data are expected to be very reliable.

Apart from that, in our study population the prevalence of AF was lower among hypertensive patients, although hypertension is considered to be a risk factor for the development of AF. We realized that the population of the eastern part of Germany has many chronic illnesses. The very fact that hypertension was prevalent in 80% of the study patients shows that concerning this disease the study patients are not comparable to general population.

Conclusion

The prevalence of AF increased considerably with increasing CHADS₂- and CHA₂DS₂VASc-scores. The prevalence of thromboembolic complications was dependent on the presence of AF up to a CHADS₂-score of 3 and CHA₂DS₂VASc-score of 6. This should warrant intensified monitoring in these patients. The prevalence of thromboembolic complications was high and independent of the presence of AF in patients with a CHADS₂-score of 4 or more and CHA₂DS₂VASc-score of 7 or more. This may indicate that the need for anticoagulation may be independent of the documentation of AF. Both hypotheses should be prospectively verified.

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